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A THEORY OF EMOTIONS AND AFFECTION BASED UPON SYSTOLIC BLOOD PRESSURE STUDIES

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I. Problem

It has so chanced that, during the last year, I have been faced with the task of compiling and attempting to interpret, simultaneously, the results of several separate systolic blood-pressure studies upon the emotional and affective reactions of adult human subjects. The original Deception Test experiments were begun in the Harvard Laboratory in 1913, and have been followed by various laboratory and applied blood-pressure investigations made by E. H. Marston, students, and myself, to the end of the academic year 1922-23. Besides Deception Test results, the researches which I have been attempting to analyze comprise the following: Sex Characteristics of Systolic Blood Pressure[1] (laboratory study); Sex and Individual Blood-Pressure Characteristics during Association Reaction-Time Work (laboratory study); Negro Blood-Pressure Characteristics (field study); Individual Female Blood-Pressure Characteristics, with Special Reference to Menstrual Variations (controlled study); Special Appetitive and Sex Studies (laboratory and applied). While I have found systolic blood-pressure change to be an exceedingly sensitive indicator of emotion, its very sensitivity to affective influence produces a complexity of resulting curves scarcely less difficult to interpret, qualitatively, than are galvanometric measurements, except where a "natural" control can be obtained, as in the case of applied Deception Tests. It became evident, therefore, that unified interpretation of the several blood-pressure studies enumerated above required simultaneous study and comparison of all results, together with experimental notes of subjects' behavior and introspection pertaining to each separate set of data. This general analysis I

undertook at the beginning of the academic year 1922-23, making such supplemental studies as seemed indicated to check up conclusions as the analysis was carried forward. Since the total data cover a very wide emotional and affective field, but cover it only very thinly, it seems advisable to reverse the usual order of presentation, and to sketch as a thesis, rather than as a conclusion, that rough skeleton of theory which seemed inevitably to rise from the total analysis. By this form of presentation, the reader may have before him this somewhat complicated theoretical structure, as a unit, in considering the application of the data and literature, when presented in detail, to the general theoretical interpretation. I do not for a moment advance the contention that the results thus assembled and cross-sectioned *prove* the theory of feelings and emotions set forth below; I merely venture to submit that fundamental interpretation which the coordinated analysis of results just completed suggested to me, in the hope that other investigators may rally to the support or attack of the theory in question, with more comprehensive data from other fields.

II. Proposed Theory

In a deductive exposition of emotional and affective theory, it may be as well to proceed from the more complex elements suggested as emotional primaries to the simpler ones. Nor is it paradoxical to characterize elementary or primary emotions as "complex," since psychologists at the present time are in general agreement as to both the physiological and psychological complexity of even the simplest emotional responses. For this reason, a search for primary emotions need not be hampered by the possible criticism, now advanced against previously postulated primary sensations, that such primaries possess only an academic, and not a psychological, existence.

(1) *Fear and Rage*

James said we are afraid because we run away, and we are angry because we attack. He also said that the emotions of fear and anger are the sensations, mostly of visceral and vasomotor origin, which occur during such flight or attack. These two statements have usually been treated as one; I regard them as widely different in both significance and application.

Struggle as we may against the inevitable implications in the affective results of Sherrington, Cannon, and the physiologists, we are, it seems to me, struggling against our own better judgment when we try to stretch the meager and sporadic visceral sensations into distinctive emotional floods of fear and rage; nor are we aided, to any great extent, when we add sensations possibly resulting from those vasomotor changes which both Langley[2] and Cannon,[3] in their work of expounding the mechanisms of the autonomic nervous system, have definitely proved so similar. Reluctant as I always have been to reject the physiologists' refutation of James' identification of emotion with special groups of sensations, my own results, both intro-

spective and behavioristically considered, made it impossible for me to subscribe to the current James-Lange formula, if I hoped to find a unified interpretation of all the studies before me. If, on the other hand, we are obliged to concede a central element in each emotional arc which gives its conscious correlate distinctive primary quality, it seems mystical, to say the least, to assume an altogether new and unique *type* of nervous path, or pattern, which would have to rank with sensation-mechanisms as an indivisible and elementary unit in our mental structure. Psychological theory is greatly clarified, it will be agreed, if sensations can be thought of as comprising all the original materials furnished by the body to the brain: the contents of consciousness, no matter how complex, thus being limited to sensations and to awareness of relations between sensations. To preserve this effective simplicity of theory seems to me to be the motive—unconscious perhaps—behind the persistent tendency of a majority of contributors to the contemporary literature to cling desperately to the original expression of James' theory of emotions, rejecting what seems to me to be the factual necessity, imposed by physiological results, of accepting a central localization for the differential element in our primary emotions. If we are willing simply to admit that James was wrong in his statement identifying emotion with sensation, and then turn to a more critical examination of his first suggestion that "we are afraid because we run," we may be able to attain our desired end of psychological simplicity of theory, without flying in the face of modern physiological fact.

Fear

If, then, we turn to a critical consideration of James' statement that we are afraid because we run away, we come first upon the apparent qualification that we are afraid when we run away from some things, and not afraid when we run away from others. A boy playing tag is not afraid when he runs from his play-fellow, who happens to be "it." A football player is not usually afraid while running away from an opponent for a touchdown. The boy might, of course, be afraid if he were running away from his father who wanted to give him a whipping; and the football player might be afraid if he were running away from a maniac who was shooting at him as he ran. Yet these instances of fear accompanying flight from dangerous objects must again be qualified. The fear experienced by our fugitives will vary in almost exactly inverse proportion to the *success of their flight.* As the small boy perceives that his father's unusual exertion is causing a shortage of breath, with consequent rapid increase of the distance between pursued and pursuer, elation begins to replace fear. But the boy is still running away. Or we may very easily suppose an instance where an experienced hunter, let us say, running for his life from an enraged bear, feels only exhilaration in the contest from the first, with no slightest tinge of fear. Surely, then, we must modify the general statement that fear *always* accompanies running from danger; although there remains the persistent idea, at the back of our minds, that both boy and football player would feel less fear, or possibly none at all, if they met their respective dangers with fight instead of flight.

Let us approach the problem from another angle. It is generally assumed by psychologists, especially absorbed in attempting to explain all human mechanisms by theoretical reconstructions of prehistoric racial history, that fear *increases the powers* of the fleeing organism, enabling it to overcome obstacles insurmountable in the absence of fear. Cannon emphasizes this conception, devoting, in fact, considerable space to enlarging upon the necessity of retaining fear and anger in human activities as "a great source of reserve energy"[4] in times of stress. This theory, it seems to me, checks up very poorly with psychophysiological and psychoanalytical results. It is difficult to discover the benefit which psychotic patients derive from that exaggeration of normal fear which may be at the root of their difficulty; nor is it apparent how the delayed reaction-times resulting, it is usually supposed, from normal fear of detection in the Association Reaction-Time Tests can be interpreted as an indicator of increased energy in those portions of the organism which are engaged in attempted escape from danger. No more, in every day experience, do we find ourselves gaining efficiency of action in proportion to the increase of our fear. It is generally admitted that, as James pointed out, we feel less fear if we oppose a threatening danger boldly, and more fear if we run from it. But if, in the first instance, when we ran instead of struggling, fear was found correlated with *inhibition* of maximally efficient action, why should we expect to find the order reversed, once we begin to run, with fear now correlated with *reinforcement* of efficient action? Or, if it is actually the most efficient course of action to run, as in the case of the unarmed hunter attacked by an enraged bear, shall we hold that fear would render his running more effective than the feeling of exhilaration? Not, at least, according to Cannon, for he describes the most efficient mental state of a football player before a big game not as dread or fear, but as a feeling of "such access of strength that he felt able, on the signal, to crouch and with a jump go crashing through any ordinary door".[5] Great danger, certainly, is often accompanied by great "excitement," which utilizes bodily reserves, and increases normal muscular performance. But, without citing in detail the accumulated proofs that, psychologically, fear is *not* efficient, I may say that careful consideration of my own results, especially those obtained upon the most successful performers in conditioned Association Reaction Tests,[6] has led me to believe that the effective element in the "excitement" produced by great danger is pure *appetitive, or self-enlarging emotion*, while the negative, hindering, opposing, inhibiting factor, whenever present simultaneously with appetite, produces the state of consciousness known as *fear*.

The psychological definition of "coward" seems clearly to be a man who is kept by fear from doing something that would be to his benefit. If a prize-fighter battles the champion, certainly it is not fear that causes him to fight, nor is it anger. It is pure acquisitiveness; he *wants to enlarge himself*, first, by getting his share of the gate receipts, and, secondly, if it is a real fight, by attaining the championship. If the contender quits during the fight, it means that *fear* of one sort or another has inhibited, somewhere within his nervous system, that driving motive of self-enlargement which led him to undertake the fight. For the moment, we are concerned with the fact and nature of this inhibition, rather than with the mechanism of the appetitive motive itself, which has its place in the next step of our attempted simplification by analysis. The contender enters the ring with the champion, with a will-setting strongly directed toward knocking the other man out. The champion batters him with heavy blows, and at first the very intensity of this stimulation merely increases the power of the contender's responses. Each time he is hit, as long as his will-setting remains intact in its original appetitive direction, the fighter hits back harder than ever. But, if the man is a "coward," the perception of his opponent's strength, skill, and apparent superiority will begin to creep *inside the contender's consciousness*. As long as the struggle between the fighters remains objective, the only way either one can win the fight is to knock the other out, *physically*. But the moment the struggle gets inside the nervous system of one or the other man, that man begins to be knocked out *psychically*; and *that is fear*. Slight inhibitions in the intensity, vigor, and accuracy of the contender's responses begin to take place, and these inhibitions pile up rapidly, until the *fighting* reactions are cut off altogether. At this point the contender begins to *retreat*, or "run away," as James puts it. The state of partial inhibition of the appetitive drive, or will-act, which is fear, begins, in this instance, some time before actual flight is commenced. The final retreat, or flight, merely *reveals the nature and direction* of the motor impulses which were warring within the contender's nervous system against those nervous impulses which had hitherto been in control. In short, the set of impulses flowing from the contender's appetitive will-setting tended to produce the total response of vigorous fighting, whereas these appetitive impulses were first gradually inhibited, and finally overcome, by a new set of impulses having their origin in sensations forced upon the contender by his opponent, which tend to produce a total response of retreat. Once retreat is accepted as a new appetitive end by the contender, however, fear will diminish once more, in proportion as this new type of willed conduct is successful in gaining its object of self-enlarge-

ment by protection from injury. If we refer back to our former example of the boy running from his father to avoid a whipping, it is perfectly plain that his fear must diminish, as we saw, in fact, it did, in proportion to the success of his flight, since, in proportion as his new appetitive end of escape is attained, the struggle which is going on *within* the boy, against this end, will tend to *diminish*, as it did with the pugilist after he once *willed to retreat*. The unarmed hunter who runs from the bear is an experienced, and therefore a "brave" man; he exerts his trained powers in a purely *objective* struggle with the enraged animal; and, since there is no struggle within his nervous system against the appetitive motor impulses directed toward saving his life by flight, he experiences no fear, but only exhilaration in the free exercise of his physical strength. In the light of this analysis, I would modify the famous James statement as follows: We are not afraid because we run away from the bear; *we are afraid because we see we are not running away fast enough.*

Of course, in running away, it is always possible that the new appetitive end of escape by flight will not be wholly accepted by the organism as its will-setting. If, for example, the experienced hunter's best judgment tells him that he need not run from the bear, but can overcome or put the animal to flight by standing up to it with a club, then the act of running would, as James supposed, *cause* fear. But, in this case, the appetitive will-setting would be directed, during the flight, *not* toward saving the fugitive's life, but toward *overcoming the bear*. As long as I continue to wish to enlarge myself by overcoming an opponent, and, at the same time, allow the more deep-seated will-end of saving myself possible pain or injury to control the motor paths to my skeletal muscles, I have committed myself to a sort of *voluntary fear*. In such case, it is not the motor impulses from sensations forced upon me by the dangerous object that enter into contest with impulses directed toward conquest of that object, but rather impulses flowing from *another appetitive will-setting* within my own organism. The struggle, in the instance suggested by James, takes place in a single flash, and is almost wholly concluded in favor of the deeper-seated will-setting at the very outset. A vague trace of the conquest-setting remains, however; not sufficient in strength to produce noticeable motor inhibition, but rather registering in consciousness as *shame* at running away. Such contest within the subject's nervous system between two opposed appetitive will-settings constitutes a sort of subjective fear, having little or no reference to sensations originating in the dangerous object, at the moment, or to the motor impulses flowing from such sensations. In fact, the latter are often virtually eliminated by the struggle of will-settings, as when a squirrel approaches a nut lying in an open space, only to retreat sharply without the slightest change of external stimulus; repeating this behavior over and over, and becoming more and more oblivious to sensations of objective origin warning of real danger, until finally a cat may run almost up to the squirrel before the latter reacts in the least to its cat-sensations. With human beings, a struggle of this sort, accompanied by subjective fear, is said to give rise to "moral courage" whenever the less deep-seated will-setting wins through to motor expression over the more archaic, or deep-rooted one. I do not believe this is the phenomenon James referred to, in his example of running from the bear; but would rather say he had in mind *true* fear, or internal struggle between being-caught and escape impulses, continuing as we run.

Finally, it may be of value to consider the application of the definition of fear suggested above to the common experience of the dissipation of fear by 'acting as if we were not afraid.' Roosevelt reports, in his autobiography:[7] "There were all kinds of things of which I was afraid at first, ranging from grizzly bears to 'mean' horses and gun-fighters; but by acting as though I was not afraid, I gradually ceased to be afraid." I take this statement to be accurate introspection, for the very reason that it emphasizes the *gradual* cessation of the emotion of fear as a response to stimulation by various dangerous objects, in proportion as the struggle between Roosevelt and the objects was gradually *ejected from his nervous system*, and carried on as an objective contest only. It is only while the conflict between appetitive and anti-appetitive motor impulses is going on within the organism that the experience known as fear obtains. The probability that anti-appetitive motor impulses will gain outlet through the nervous system of the organism depends wholly upon the nature of the unit-perception[8] of the relation existing between the organism and the appetitive opponent. As long as the subject is *fighting* the bear, horse, or gun-man, the unit-perception of the relationship between subject and opponent is less likely to gain anti-appetitive motor expression, because the relationship perceived is less unfavorable to the end willed, or desired by the subject. When the subject has decided upon flight, even though in making the decision he may have remained uninfluenced by fear, the perception that he is forced to run away in itself connotes that he is weaker than his opponents, and this perception is, therefore, just so much more unfavorable to the end willed than was the perception of a fighting relation between subject and opponent. If the subject can force himself to go through the motions of fighting, or of behaving as if he were exactly as strong as his opponent, he thereby furnishes a unit-perception for his own senses which has far less chance of setting up opposition, in his nervous system, against those motor impulses which are being directed by his will-image or will-setting toward the end of self-enlargement. The subject, in such cases, is an actor, performing before himself as audience, for the purpose of furnishing a show which will eliminate any desire, on the part of the spectator, to leave the theater. If this performance is sufficiently convincing, and can be continued long enough, the dramatic illusion is bound to supersede, to a greater or less extent, an awareness of the world of reality. Former perceptions of a stronger-weaker relation between opponent and self become mere memories, and these memories grow fainter and fainter. It is not, however, until the last such memory has been completely eliminated from participation in the total motor expression of the organism that fear wholly ceases; because, until that time, anti-appetitive impulses flowing from the memory-images of the superiority of the opponent will continue to struggle with the motor impulses directed by the subject's will-setting toward self-enlargement, for control of the motor outlets of the organism. If the acting is not wholly convincing, or if it is not uniformly continuous, new perceptions of the opponent's superiority will be received by the subject's senses, and the motor conflict, or fear, will be renewed from this source.

Such analysis of Roosevelt's experience serves to explain the everyday fact, noted under our initial review of James' statement about fear, that fear more frequently accompanies the saving of the self by flight than it does the accomplishment of the same appetitive end by fight or attack. While the subject is attacking his opponent, he is furnishing a convincing drama depicting his equality with, or even his superiority to, his opponent. But while the subject is fleeing from an opponent, the drama is equally persuasive of his opponent's superiority. In war, "strategic retreats" are the most difficult of maneuvers simply because the drama is so convincing that the retreating army itself is convinced of its opponent's superiority, becomes afraid, and the stratagem is likely to be turned thereby into a

reality. On the other hand, situations are not rare where fear decreases tremendously when fight is suddenly turned into flight. If a small body of men is sent out to attack a strongly fortified position, frank introspection reveals that fear increases proportionately with their increased perceptions of the enemy's strength, and decreases sharply, or even ceases altogether, when the attack is given up, and they are free to run back toward their own lines. During attack, in such cases, perceptions of the opponent's superiority increase steadily, except as such perceptions may be obscured or inhibited by the subjects' own acting; whereas during flight, in which they know the enemy can not pursue them, perceptions of the stronger-weaker relation between self and opponent steadily fade out, or cease altogether, and fear similarly ceases. As long as we entertain perceptions of our opponent's superiority, while we are fighting him, we shall *tend to run away*, whereas *we want to fight;* and this conflict is the correlate of fear. And, if we elect to run away, and simultaneously allow ourselves to harbor perceptions of our opponent's catching us, we shall *tend to be caught* although *we will to run faster;* and here, again, we experience the conflict which is accompanied by fear. To refer, once more, to the bear-case cited by both James and Roosevelt, our fear does not cease when we have trained ourselves not to run away from the bear, but only when we have trained ourselves *not to perceive the bear's superiority* while we are fighting it. And, if we decide to flee from the animal, our fear ceases only when we have trained ourselves *not to perceive that we are being caught* while we are running away.

I should define fear, then, as the awareness of a motor conflict within the organism, at a nervous level correlated with consciousness, between motor impulses flowing from an appetitive will-setting, and motor impulses from anti-appetitive perceptions. An "appetitive" will-setting, or unit will-image as I propose to use the term, is one directed toward self-enlargement; and the source and nature of such settings must be considered in detail below. An "anti-appetitive" unit-perception image is a unit-perception of environmental factors tending toward self-depletion; and, if we accept in full the ideomotor theory, such a unit-perception, in so far as it is allowed to bring its meaning into consciousness must, in just so far, gain motor outlet through the organism's musculature for impulses *tending to move the organism toward self-depletion.* I will to escape the bear. This is my appetitive will-image. From this setting flow motor impulses moving my legs rapidly. I then perceive that the bear is gaining upon me. In so far as this unit-perception gains the meaning of *being caught by the bear,* in my consciousness, in just so far do its motor impulses slow up the movements of my legs. Unless the inhibiting or slowing impulses did gain just such outlet, I could, of course, have no awareness of being caught, or depleted by the bear. This is my anti-appetitive perception image. Will says: "Run!" Perception says: "Give up!" The state of consciousness correlated with a conflict between these settings, with their constituent and concomitant sensations, is fear.

Anger

The statement "We are angry because we fight" seems to me less significant than James' famous description of fear, considered above. Most fighting, between both men and animals, according to my analysis, is accompanied by the active phase of appetitive emotion, to be considered in the next stage of analytical simplification. The fierceness evidenced in battles between animals, prize-fighters, or business men, has in it, according to my results, no element of conflicting impulses within the nervous systems of the fighters. There is, on the other hand, a maximally efficient unification of motor impulses rigidly enforced by the appetitive will-setting. This is not rage, or anger; for anger, according to the analysis of my introspective results, always contains an element of feeling "defeated", or "baffled." In other words, there is a motor conflict of some sort going on within the organism, between will-setting and perceptions, just as is the case during fear. The distinction is, in my opinion, a crucial one; and is actually very easy of application, even in a purely objective study of animal or human behavior. Appetitive conduct, no matter how violent and aggressive it may be, is perceptibly shaped toward the end of self-enlargement. Angry conduct takes no heed of self-enlargement or self-protection, but is directed only toward destruction of some object outside the self, and, in true anger, includes the self also, to a greater or lesser extent, as an object of destruction.

In any purely appetitive struggle, the opponent wills and expresses in bodily action a unit-image of self-depletion. That is, each prize-fighter is voluntarily shaping his behavior toward depleting his opponent, as a means towards enlarging himself. But this final end of self-enlargement is the controlling one, and the more completely it does control his conduct, the fiercer and more effective his attack becomes. Other, and more deep-seated appetitive ends, such as protecting his body from injury, and conserving his strength for future battles, may be eliminated by the immediate appetitive end of winning this particular fight. It is at this point that his behavior is often said to be expressive of rage, but as long as the fighter's blows are both maximally powerful and maximally well-directed, his behavior expresses only appetite.

If his blows begin to weaken owing to central motor inhibition, it is evidence that a state of fear is setting in. If, on the other hand, he begins to shower blows at random on his opponent, regardless of rules or result, it is evidence that his original appetitive end of winning the fight is being diverted into the slightly different purpose of dominating his opponent at all costs. This type of behavior certainly denotes a motor conflict within the fighter's nervous system, which might well be classified as true anger were it not for the fact that there is not a genuine tendency in such conduct toward self-depletion, or destruction. The fighter, in discarding his skill and craft, as well as his defensive reactions, has certainly laid himself open to greater depletion or injury than before. But his own movements do not tend to bring such depletion about, save as a result of negligence. He does not "rush on the spears," and gather them to his breast. The distinction is rather a fine one, but is, I believe, accurate. There is a conflict of motor patterns; but both patterns are appetitive, and, therefore, both are aimed

at self-enlargement. The first pattern is directed toward winning this prize-fight; the second, and interfering pattern is directed toward dominating a particular individual, regardless of winning the fight. The opponent has succeeded in substituting himself, within the will-image of the fighter, for the fight decision, as central object in the end to be attained. There is no radical variance between the direction of the motor impulses flowing from the appetitive image of winning this fight, and the direction of the motor impulses flowing from the appetitive image of subduing this individual at all costs; but there is just enough variance to inject "wildness" into the fighter's behavior, and to add that tinge of "baffledness" or "defeat" to the fighter's consciousness which is the conscious correlate of the blocking, or partial blocking, of motor impulses from the original appetitive will-setting, within the central nervous system. This state of the organism is very close to anger, and constitutes, in fact, the type of response most frequently produced in laboratory animals and human beings, upon interruption of various appetitive will-settings, and reported as true anger. Since that motor element of self-depletion which constitutes, according to my analysis, the peculiar differential criterion of true anger is missing, however, I shall call this defeat, or diversion of one appetitive setting by another, "pseudo-anger."

On just the other side of the line, however, lie many cases of true anger *following* the complete defeat, or elimination of an appetitive will-setting. If an appetitive opponent succeeds in substituting the essence of his will-setting for the appetitive one originally held by the subject, then anger results. The essence of the opponent's will-setting which must be accepted as the subject's own is depletion of the subject. The unit-perception image will then include a substitution of opponent for self in relation to the property or object formerly possessed by the subject, and now possessed by the opponent. The result will be a depletion-response directed mostly at the self, but always in conflict with a tendency to direct it toward the victorious opponent, in so far as motor impulses from the unit-perception image of substitution of opponent for self are able to gain outlet through the subject's organism. This is true anger, but of an unstable type, usually tending to revert to the original appetitive response, automatically, after a very brief interval, since the will-image of self-depletion has been artificially imposed. A little boy, for instance, asks his mother for a big piece of cake. She represents his appetitive opponent when she refuses to let him have the big piece he wants. Finally, she consents to his having a little piece. The humiliation of appetitive defeat has been thrust upon the boy. This victory of his appetitive opponent may loom larger, for the moment, than his desire for cake; and if so, he may adopt for his own his mother's will-image of self-depletion. In this case, he rejects the little piece of cake, perhaps forcibly, and begins to cry. In short, "he cuts off his nose to spite his face." The rejection of the smaller piece is action proceeding from the child's artificially adopted will-image of self-depletion; while the forcibleness of such rejection, and the crying and possible pounding of the table, are the bodily expression of motor impulses directed by his unit-perception image of his mother substituted for himself as possessor of the piece of cake he wanted. The instability of this self-depletion will-setting, however, is usually evidenced by the little boy's hurried grasping for the smaller piece of cake, if his mother threatens to remove it from the table altogether. Sometimes, in adults, this type of self-depletion motor setting, following defeat of some deeply ingrained appetitive response, persists long enough for the subject to commit suicide; but if the means chosen is not a rapid one, or if, in the course of the act, sensations arousing still more deeply seated appetitive responses than the one defeated gain the subject's attention, his will-setting immediately reverts to an appetitive one, and the perception of suicidal environment becomes a stimulus to fear.

The generic source of that type of motor conflict within the organism which constitutes true anger seems to be sex-rivalry. As I shall attempt to set forth at greater length below, the sex will-setting is one of self-depletion. The animal or human sex-subject wills that the sex-object shall deplete him, in the fulfilment of some vital need or desire of that sex-object. But, since no organism can escape from the egocentric predicament, this typical sex will-setting takes the form of active self-depletion, with the self in both rôles of depleter and thing depleted. In its rôle of depleter, however, it is a mere substitute for the sex-object; and, during the actual sexual act, the sex-object does, in fact, actually become the active depleter, since it directly stimulates reflex mechanisms by which part of the self is ejected to serve the needs of the sex-object. The essence of the sex will-image, therefore, is the self as thing depleted; just as the essence of the appetitive will-setting is the self as thing enlarged. If it were true that the essence of sex-desire is the wish to *own*, or *possess* the sex-object, then intrusicn of a rival would simply result in a true appetitive struggle, with each contestant acting primarily to enlarge himself. Sex-combats give every evidence, however, of reckless abandon of self, and, in fact, of an admixture of behavior voluntarily directed toward self-depletion. In no instance of animal appetitive contests do we find the opponents mutually respecting a set of rules operating, to a considerable extent, as a handicap in the gaining of the end desired. Yet not only are animal courtships governed by formalities more or less strictly observed, but even the combat of rivals, in many species, is carried out in accordance with a mutually respected form of procedure. Challenges to open fight are issued, and accepted, and other males present refrain from interference, in most instances. All these items of behavior are in the nature of deliberately willed limitations placed by the animal upon itself, and could not, therefore, proceed from a will-setting directed toward self-enlargement. The same animal, when in search of prey, leaps upon its victim from ambush, even if the animal attacked is very much smaller than the attacker. In an appetitive struggle no slightest advantage is sacrificed, and every movement—save those symptomatic of a state of fear—is directed toward the greatest possible self-enlargement.

If, as I suggest, the sex will-image is one of self-depletion, combats of sex rivalry, accompanied by that state of motor conflict by which I have defined anger, are very easily explicable. Each sex-subject wills to deplete himself, at the dictation of the mutual sex-object. The intrusion of a rival tends to force upon the subject the unit-perception of the rival as thing depleted by their mutual sex-object, in place of the self. In just so far as this perception of the substitution of rival for

self is forced upon the sex-subject, to exactly the same extent will those motor depletion impulses which were directed by the will-setting against the self, now be diverted toward the rival. The result will be a will-setting of depletion, with a conflict of motor direction of the resulting impulses as between self and rival; which total condition of the organism will have anger for its conscious correlate (just as the same type of motor conflict following the artificial substitution of a will-setting of self-depletion for the appetitive setting of self-enlargement was found to be accompanied by true, though transitory, anger). In the sex-rivalry anger-response, however, a much larger proportion of the total depletion-impulses would seem to be directed against the opponent than in the post-appetitive anger situation. Human suicides, following loss of a lover to a rival, are fairly frequent; but usually the rival is killed first, and the subject's ensuing suicide, if it occurs, is attributable, perhaps, in part, to the cutting off of appetitive setting toward life itself, on account of anticipated social complications inevitably following murder. In general, however, sex-rivalry anger represents a much more stable and enduring motor condition of the organism than is found in post-appetitive anger; and is, in fact, likely to persist as a response to perception of the rival as long as the original sex will-setting toward the particular sex-object persists. In sex-rivalry anger, moreover, is probably to be found the original source of that definite motor conflict pattern, into which the peculiar, though frequently recurring, post-appetitive emotional situation above considered falls.

The anger of a mother, animal or human, aroused by the intrusion of any object or organism between herself and her offspring, constitutes a still more objectively directed and enduring condition of motor conflict of the type described. The material reaction to the young constitutes, according to my analysis, a singularly pure type of true sex-response; and it seems to me wholly unnecessary to postulate any additional "instinct," or primary emotion, wherewith to describe this reaction. The mother simply acts under the control of a strongly organized self-depletion will-setting. She wills to serve her young; to deplete herself, both by furnishing milk from her own body, and by expending her strength in their service. If the essence of sex is to make the self the thing depleted by the sex-object, what clearer sex-setting is possible than that of the mother toward her offspring? In such a definitely organized setting, perception of the interposition of any strange object or organism between mother and young is likely to effect an almost complete subsitution of the intruding object for the mother's self, as the object toward which her depletion impulses are directed. The state of motor conflict, within the

mother's nervous system, between the impulses directed toward depletion or sacrifice of herself for the protection of her young, and the impulses directed toward depletion or destruction of the intervening object, constitute a long enduring, as well as an exceedingly intense state of true anger.

Finally, in considering interruptions of sex-response which give rise to anger, the most enduring of all, as well as the most objectively directed, would seem to be that occasioned, under certain conditions, by rejection of a female subject by the sex-object. According to indications reported in a previous paper,[1] the sex-responses of female human subjects are much more extensive than are those of males, and are found to be organized in larger units. From this result it is, perhaps, a fair conclusion that a female subject's sex will-impulses of self-depletion constitute a much larger proportion of her total motor activity than do the sex-impulses of the male. Therefore, when the substitution of the sex-object for herself as the object toward which those depletion impulses are directed is accomplished, her attack upon the substituted object must be correspondingly extensive and enduring. The resulting reaction, in human subjects at least, would seem to justify the well-known literary precept:[9]

> "Heaven hath no rage like love to hatred turned,
> Nor hell a fury like a woman scorned."

By rejection of all the services and substance offered by the sex-subject, the sex-object has transformed himself into a complete barrier interposed between the subject's self as depleter and the same self as thing depleted. Since the sex-object was, in the first place, a stimulus to the subject to act as depleter, he continues to be such a stimulus, necessarily, since he can not change his appearance or nature as sex-object. But, on the other hand, he is the only organism or object with the power to eliminate completely, by rejection, the sex-subject's self as thing depleted, and, in so doing, to substitute, almost as completely, himself for the subject's self as thing depleted, within the sex will-image of the subject. Since the depletion-impulses are identical in sex-response and anger, in this instance, the stimulus remaining the same, the "hate" or anger-attack upon the sex-object is bound to be exactly as extensive and enduring as was the original "love" behavior, or offering of the services and substance of the self to the sex-object. In this type of anger, the conflict of directions of motor impulses is almost completely resolved in favor of the objective direction, in contrast to the post-appetitive type of anger where scarcely any substitution of object for self takes place, and the depletion-impulses are consequently almost wholly directed against the self. Between these extremes lies a great number of types of

blockages of sex-responses, differing only in the proportion of the total depletion-impulses directed toward self and toward intruding object.

The above resolution of fear and anger into motor conflicts of distinctive types of action-patterns places these responses upon a purely mechanical basis; and places the neurological correlate of the distinctive conscious qualities of fear and anger solely upon the motor side of each individual sensation arc, summated, in all probability, for each unit-pattern, in cortical paths furnishing, as conscious correlates, symbols of conflict-relationships existing between the definite types of motor impulses involved in the conflict. The fear-type of motor conflict is between enlargement and depletion impulses; while the anger-type of motor conflict is between the direction of existing impulses toward the self and toward another object. Obviously, neither type of motor conflict can be as effective, in physical work performed, as any unified and non-conflicting group of constituent impulses. Pure appetitive behavior is bound to be more efficient than is behavior resulting from a conflict between appetitive and anti-appetitive impulses. And pure sex-responses will prove, inevitably, more effective than a response of the same type which the organism is seeking to direct against two different objects simultaneously. But, if a choice must be made between the two types of motor conflicts summarized here, anger should prove more efficient than fear, since there is less motor conflict involved. In fear, motor impulses of reciprocal opposition are struggling against each other, within the organism; whereas, in anger, only the direction in which the same impulses shall be pointed is in issue. Once we get over the notion that escape from danger is a fear-response, and place self-preservative retreat in the same appetitive category as the procuring of food, we find our everyday experience confirming the above theoretical conclusion as to the relative efficacy of fear and anger. Anger may remove a sex-obstacle before the subject himself is destroyed; whereas fear tends only to defeat the most vital needs of the subject. If my analysis is correct, however, both fear and anger represent imperfections in natural evolution, and not biologically useful types of response. Appetitive response was developed to build up the individual organism, and sex-response was evolved for the purpose of giving the individual organism something to do with the power it had acquired. The perpetuation of the race, as I see it, goes on continuously, almost independent of the lives of individual organisms, since the germ cells are practically isolated from their somatic environment, are probably capable of perpetual life, and might easily be stimulated to combination and reproduction by mechanical means, as happens in the cases of some lower organisms. The individual sex-mechanisms serve, in essence, only to furnish each organism with a constructive outlet for that substance and energy which is taken in through the appetitive mechanisms. Fear and anger constitute the primary types of opposition to appetite and sex, respectively, within the individual organism; and all other emotional patterns are either variants or complexes of appetite and sex, fear and anger.

(2) *Appetite and Sex*

In the course of the above analysis of the complex emotional responses of fear and anger, "will-settings" or "will-images" of appetite and sex were referred to, in contradistinction to motor settings, patterns, or images flowing from the sensations constituting a unit-perception contradictory to the will-image. In the ordinary nomenclature of psychology, such a distinction would probably not be permissible, since motor patterns set by

any sensation or perception unit would equally deserve the name "will-settings." I have ventured to limit my use of the terms "will-image" and "will-setting", however, to those motor patterns which are set up by the primary agency of mechanisms inherent in the organism; and since I have found only two such mechanisms, hunger and sex, my use of the term "will" is necessarily confined to motor settings of appetitive and sex types and origin. Of course, it would be absurd to contend that each separate, individual will-setting is the direct result of the operation of one of these mechanisms; but it is my thesis that the two distinctive will-patterns of self-enlargement and self-depletion are formulated by the inherent mechanisms, respectively, of appetite and sex; and that responses within these will-patterns, thereafter, become conditioned upon environmental stimuli both adequate and inadequate to the original responses, selected by the organism upon the general principle, found within the inherent mechanisms, of escaping the unpleasant, and seeking the pleasant. Since my method in this preliminary exposition of emotional theory is an attempted simplification by analysis, it becomes necessary, first, to consider the inherent mechanisms upon which the fundamental will-setting types are postulated; and, secondly, to analyze these biological mechanisms further for the purpose of discovering, if possible, an inherent basis for pleasantness and unpleasantness.

Appetitive Response

By the use of the term "appetitive response" I do not intend to draw a distinction between appetite and hunger, but rather to include both, as defined by Cannon[10], within the inherent supply-mechanism of the organism. I have used the term "appetitive mechanism," since this name would seem to possess more psychological significance than would the term "hunger mechanism." Hunger pangs have been proved by Cannon, Carlson[11], and others, to consist of those sensations which occur during strong contractions of the empty stomach, and possibly of the oesophagus. These contractions seem to be set up, partially by a "hunger hormone" generated by body tissues in need of nourishment, and partially by a specific nervous automatism, both central and peripheral, and independent of afferent impulses.[12] Such a mechanism as is thus described seems totally independent of environmental stimulation, and does not, in fact, depend upon any single factor outside the organism for its origin or development. That the hunger mechanism is inherent is clearly indicated by studies made by Carlson and Ginsburg,[13] upon new-born infants, and upon two pups born 8 to 10 days before the term. Typical periods of tonus and hunger contractions were found, resembling those of adult organisms, with the exception that the contractions of the

infants' stomachs showed relatively greater vigor and frequency. These hunger pangs appeared shortly after birth, and before any food had been taken into the stomach. We have here, clearly, a mechanism designed to initiate appetitive response, which is both inherent and automatic.

Proceeding with the action of this appetitive mechanism, then, we find that it initiates a type of behavior directed toward enlargement of the organism, before the infant is 9 hours old.[13] Cannon describes the action of the organism resulting from hunger pangs as follows:[14] "Hunger, in other words, is normally the signal that the stomach is contracted for action; the unpleasantness of hunger leads to eating; eating starts gastric digestion, and abolishes the sensation." Contained in this succinct exposition of the behavior initiated by hunger pangs, are a considerable number of psychophysiological reactions of the organism, all fitting together to form integral portions of the total appetitive response. Four principal psychophysiological units compose the complete appetitive mechanism: (1) an unpleasant internal stimulus, hunger pangs; (2) motor or will setting toward enlargement of the organism, set up by this internal stimulus, and psychically represented, following the formation of associative connection between stimulus and food, by the will-image of food; (3) motor impulses, directed by this will-setting, which result in behavior directed toward procuring food; (4) eating and swallowing the food procured, which results (*a*) in the cessation of the unpleasant internal stimulus, hunger pangs, and (*b*) in what Cannon calls "the relatively mild pleasures of sight and taste and smell of food".[15]

Once the second unit above mentioned, *i.e.*, the will-setting toward self-enlargement, has become conditioned upon the sight, smell, or other perception of certain food, or other objects as an effective stimulus, then the first step, or adequate internal stimulus may drop out, and the total appetitive response proceeds as before, except that the effectiveness of the substituted stimulus is the element that drops out in the final stage of the response, after the food or other object has been assimilated by the organism, in place of the unpleasant adequate stimulus. In other words, the sight and smell of delicately prepared food may set off the appetitive response, as Cannon points out[16], long after hunger is satisfied; but there comes a point, in the behavior of the most confirmed glutton, where appetizing food no longer tempts him, and he stops eating. The effectiveness of the substituted stimulus, food, has dropped out, just as the adequate stimulus, hunger pangs, ceases after sufficient afferent taste, smell, and swallowing impulses, with reflex motor outlets through the cranial autonomic, have been set up by the natural process of eating to inhibit the hunger pangs; aided, very pos-

sibly, by other reflex mechanisms set off by the filling of the stomach with food.

No "instinct," or other inherited cortical pattern, seems to me to be necessary as prerequisite assumption to an adequate explanation of this extremely simple, yet absolutely basic, appetitive mechanism. The newborn infant needs only a normal alimentary canal, afferent nerve connections between canal and central nervous system, and efferent nerve connections between central nervous system and skeletal muscles, for a bodily reaction to occur in response to hunger pangs (which, in the first place, have been initiated, very probably, by automatic chemical reaction to reagents contained in the blood-stream). The first bodily movements of the newborn infant are, as we know, of the "random" or uncoordinated variety[17]. Many different types of random movements are doubtless set off in response to infant hunger pangs, some observable, and others not readily accessible to inspection. There may, possibly, be prenatal dispositions tending to connections between the sensory center where the afferent impulses from the stomach are received and the motor nerves leading to the larynx and effector organs necessary to produce crying, and other recurring infant responses; although, personally, I doubt it. The "birth cry," caused, of course, by the mechanical inrush of air to the infant lungs, seems to me sufficient to lower the synaptic resistance in the motor centers and afferent paths necessary to the crying response, which would then tend to result from any other unpleasant stimulus, internal or external. Gradually, touch sensations, and later taste sensations, from mouth and lips, would be built into the response, as the infant was nursed; and incidental touch sensations caused by contact between infant hands and mother's breast, or bottle, and coordinated with the grasping reflex, would, still later, gradually carry the appetitive response into a *grasping* type of behavior. From this to the mature adult appetitive behavior, directed toward food and other objects, is a simple, and comparatively short step; and would naturally be expected to develop by the ordinary learning or conditioned-reflex process, without interposition or necessity of any further inherent connective factors. Only the general *type* of motor setting, *i.e.*, a setting to produce self-enlargement, remains unaltered from the first completed appetitive response of life to the last; and it is reasonable to suppose, therefore, that this type of motor setting should become more deeply inwrought as a central, controlling neural pattern of human and animal behavior than any other; as, in fact, it does.

Having suggested a psychophysiological mechanism, inherent in the organism, by which the self-enlargement pattern of behavior characterizing what I term the appetitive response may be built up, it becomes necessary for me to analyze this response from the psychical side, in an effort to determine its conscious emotional correlates. Analysis of my own results shows, briefly, that the appetitive response, in its affective aspect, progresses, if successful, from sharp unpleasantness (hunger pangs), through a mixed pleasantness and unpleasantness (pursuit and capture of food), to the disappearance of initial unpleasantness, and a rather extended pleasantness of slight intensity (cessation of hunger pangs and the eating of acceptable food thereafter). If unsuccessful, appetitive response may progress from unpleasantness (hunger pangs), through a stage of unpleasantness aggravated in both intensity and duration (failure in pursuit, or defeat in attempt to capture

food), to a final condition of extreme unpleasantness (progressive weakening of, or injury to, the body). The distinctive emotional quality accompanying successful appetitive response, throughout, may be designated as *appetitive emotion* and that accompanying unsuccessful appetitive response, if the anti-appetitive situation is allowed motor expression within the nervous system of the organism, is *fear*.

Appetitive response following the initial stimulus, hunger pangs or a substituted effective stimulus, may be conveniently divided into two parts, or aspects: the active aspect, and the passive aspect. Immediately following the formation of the appetitive will-setting, the organism starts into more or less violent action, toward the end of finding and capturing food. This is the aggressive, fighting, *dominant* aspect of the appetitive response; and in proportion as it succeeds, pleasantness from the perception of its success is added, in consciousness, to the unpleasantness of the original hunger pangs, or awareness of unsatisfied craving. This mixture of pleasantness derived from perceptions of accomplishment, by the organism, of the first part or aspect of that appetitive image toward which the response is directed, and of unpleasantness derived from the original stimulus, or awareness of unpleasant cravings, constitutes the emotional state known as *triumph*. This half-way station in appetitive emotion seems to be found peculiarly pleasant by some types of organism, such as the cat. Playing with the prey, before devouring it, and other prolongations of the triumph-aspect of appetitive emotion, in fact, characterize the behavior of many species, including man.

The final, or passive phase of the appetitive response begins with the eating and swallowing of food. Both the unpleasantness of hunger pangs, and the intensity of the pleasantness derived from perceptions of dominance, now begin to diminish. The hunger pangs completely disappear after a relatively small portion of food has been consumed, leaving, still, some pleasantness of dominance, though this is greatly reduced in intensity. A new pleasantness makes itself felt, now, apparently, from the smell, sight, and taste of the food being eaten. Elation seems to be the phase of appetitive emotion differentiating this final or passive aspect of successful appetitive response from the preliminary, or active aspect. Elation is composed of the pleasantness flowing from a perception of the abolition of the unpleasant stimulus to appetitive response, or escape from unpleasantness, *plus* the positive pleasantness accompanying the food sensations. The fusing of triumph and elation constitute, I suggest, the consummation of the distinctive quality of appetitive emotion, which, as a unit, may be defined as an awareness of successful, willed self-enlargement, with the pleasantness

flowing from such awareness and from the self-enlargement *per se*. Since nomenclature of the conscious correlates of emotional responses is based upon introspective terminology, it seems to me of little importance what names are chosen, so long as the distinctive elements of each emotional aspect are definitely designated, and the same name is always used as a symbol for the same emotion, or emotional aspect. The names "appetitive emotion," "triumph," and "elation," therefore, as used in this paper, should be understood by reference to the psychophysiological elements herein assigned to each, rather than by reference to the individual introspection of the reader, or of some other writer. Bearing this caution in mind, I may summarize, as follows, the two aspects of appetitive response, and their corresponding conscious emotional correlates, together with the related "anti-" or conflict states of the organism.

Appetitive Response
(Will-setting toward self-enlargement)

	Successful	*Unsuccessful*
	Active	
Perceived relation of organism to appetitive object	Dominance	Subjection
Emotional correlate of perception of such relation	Triumph	Shame
	Passive	
Perceived relation of organism to its previous state	Enlargement	Diminution
Emotional correlate	Appetitive Emotion (Triumph *plus* Elation)	Fear

In comparing the objective efficiency of fear and anger, the point was made that flight from danger was primarily an appetitive response, which was accompanied by fear only if motor impulses from the unit-perception of the unsuccessfulness of the flight gained expression in the bodily behavior of the organism; in which case the flight was hampered, and rendered less efficient. During discussion of fear, the relation of fear to flight was expressed by the statement: We are afraid of the bear because we do not run away fast enough. These points should now be made clear by consideration of the primitive or original course of the appetitive response. If the above analysis is correct, appetite consists, primarily, in a flight, or escape from unpleasant stimulation. The entire response is directed toward the removal of disagreeable sensations indicative of threatened depletion or diminution of the body. In short, whether the behavior necessary to bring about the willed result of self-enlargement is capture of food by fighting, or fleeing with stolen food, the biological, as well as the psychological purpose of the en-

largement is to escape the danger of starvation. After the appetitive response has become conditioned upon various specific articles of food, and other objects, as effective stimuli, the primitive nature of the response as an escape from unpleasantness warning of danger is not so apparent; but once this essential characteristic of natural appetitive behavior is considered, it no longer appears a logical, psychological, or biological necessity to correlate flight with fear.

Finally, brief consideration must be given to the enormous extension of the appetitive response in human behavior. Crows, and a few other exceptional species of lower organisms, collect various articles other than food, and behave toward such objects in a manner that may fairly be said to indicate a conditioning of the appetitive response upon these objects as effective stimuli. Human beings, however, have so far transferred the response from its naturally constituted type of edible stimulus, that food is often neglected, maldigested, or even wholly rejected over considerable periods of time, while the subject expends all his energy upon concerted efforts to enlarge himself by the acquisition of property in, or control over, an innumerable number of objects bearing not the slightest relation to bodily nourishment. In some instances, perhaps, a native defect in the digestive or assimilative mechanisms of the body may bring about a very complete reconditioning of this type, and certainly in those instances the appetitive response toward money, and material objects other than food, would seem to be aggravated in its intensity. J. D. Rockefeller, for instance, has suffered with digestive troubles for a long period; but whether such failure of the digestive mechanism is the cause or result of unusually complete transfer of appetitive response to new categories of stimuli could be determined only by study of the individual case. Literature abounds in association between "the lean and hungry look" ascribed to Cassius by Shakespeare[18], and the seeking and attaining of great wealth; whereas such impecunious individuals as Omar Khayyam are currently described as rotund. While such naturalistic observations can possess only fragmentary value, at best, they serve to suggest the possibility that, with the growth of cerebral activity, the human appetitive response has been conditioned upon inedible objects as effective stimuli to such an appreciable extent that insufficient appetitive emotion remains correlated with the processes of bodily sustenance to induce the formation of behavior-patterns directed toward the procuring and proper digestion of food. Again, the very enrichment of cortical connections, due to extensions of human cerebral activity, very probably tends to build up human appetitive responses directed toward objects other than food. Whatever the cause, the average "civilized" human subject feels triumph and elation only in the course of establishing dominance over, or in completing the assimilation of, money, land, economic wealth, and mental or physical possessions of various types other than those suited to nourish the body. This conditioning of the response, with its correspondingly characteristic emotional states, upon diverse non-digestible objects as effective stimuli, however, in no way impairs or alters the primitive type of the appetitive response-pattern; nor does it change, as far as current literature and present human activities afford bases for judgment, the nature of the archaic emotional states of triumph, elation, appetitive emotion, shame, and fear. It is but another indication of man's reluctance to associate himself with his origins, that the simple appetitive response has never assumed its proper place as the mainspring of human behavior. Certainly it has long been recognized as the central pattern in virtually all types of animal activities unrelated to sex; and it would be strange, indeed, if any considerable gap were to be

found, in this particular more than any other, between animal and human responses. The inherent hunger-mechanisms, the flight and fight types of behavior in attempted escape from the unpleasant stimulus, and the types of will-setting directed always toward self-enlargement, are all identical in human and lower animal organisms and behavior. Therefore, the conclusion that these factors are characteristic of an identical appetitive type of response does not seem difficult, or far-fetched.

Sex-Response

The classical description of the innervations of internal and external genital organs is that published by Langley and Anderson in 1895[19], and subsequent experimentation has shown that this exposition is sound. In both male and female, external genital organs are innervated, mainly, through the *nervi erigentes*, while the internal genitals are innervated through sympathetic rather than sacral fibers. Erection is brought about, therefore, through the sacral division of the autonomic, and ejaculation through the lumbar division of the same nervous system. Although, in both sexes, coitus is correlated with intense affective consciousness, the neurological mechanism is wholly reflex, and the act may be completed after all impulses from higher centers have been cut off by section of the cord in the dorsal region[20]. Steinach[21] has shown that sexual puberty is dependent upon the internal secretions furnished by the interstitial cells of Lydig, lying outside the seminal tubules, in the male, and by the interstitial cells of the ovary, in the female. Secondary sex-characteristics, menstrual function, and "heat" all depend upon this internal, or secondary secretion; and are totally abolished if the interstitial cells are removed, although not if the reproductive cells are missing. These results furnish us with the completed picture of an automatic, inherent nervous mechanism, with a chemical stimulus capable of setting it off, designed to initiate sex-response exactly as the hunger-mechanism above considered is inherent, automatic, and capable of initiating the appetitive response.

The action of this sex-mechanism, however, results in a type of behavior exactly the reverse of that following the operation of the appetitive mechanism. The sex-response consists, in brief, of seeking an organism of opposite sex; offering the self to this sex-object as mate; and performing, with the sex-object, an act of coitus, which consists in each party to the transaction stimulating the other in such a way that each ejaculates, or throws off, part of the self. Following our appetitive analysis, above, four psychophysiological units may be discovered in this sex-response: (1) a pleasant internal stimulus, "heat;" (2) a motor or will setting toward depletion of the organism, represented by the image of the sex-object following the forming of association connection between sex-stimulus and an organism of

opposite sex; (3) motor impulses, directed by this will-setting, which result in behavior directed toward finding, and being accepted as mate by, the sex-object; (4) performing an act of coitus with the sex-object, which results in great enhancement of the pleasant internal stimulus, "heat." As with the appetitive response, the adequate or internal stimulus is soon supplanted, or supplemented, by the conditioning of the entire response upon the sight, smell, touch, or other sense perception of the object of the response, once that object has been determined, as effective stimulus. Again, as "heat" tends finally to be eliminated, after the orgasm has consummated the end willed, so the effectiveness of the substituted stimulus, sex-object, is reduced or eliminated at a similar juncture.

While it is, perhaps, of negligible importance whether this sex-response be referred to as an "instinct" or not, I call attention to the fact that no inherited cortical pattern is necessary for the behavior of any organism in this typical sexual pattern. There are, to be sure, inherited nervous connections, afferent and efferent, by which stimulation of mature external genital organs may produce an orgasm, or ejaculation of certain materials from the organism; and there are, also, inherent afferent connections between sensory sex-receptors and the brain, and inherent efferent connections between the brain and the skeletal muscles of legs, arms, and body, and between the brain and the lumbar center controlling the sex-reflexes.[22] But, unlike the case of appetitive response, the sex behavior-pattern is not built up while the organism is in its infancy; and there is still less difficulty, therefore, in supposing that environmental stimulations may be solely responsible for the conditioning and development of the mature sex behavior-pattern, following the initial "heat" set off by a secretory stimulus, from within the body. However this may be, the important point for the purpose of this paper is the fact that both reflexes and cerebral sex-paths never produce any type of behavior other than that directed toward self-depletion.

The affective accompaniment of sex-response, during uniformly successful development toward the end willed, proceeds from a pleasant internal or external stimulus, through an evenly graduated scale of increasing pleasantness, to a final intensity of pleasant affect probably surpassing that accompanying any other response of the organism. The distinctive emotional quality accompanying successful sex-response, throughout, may be designated, with equal accuracy, as sex-emotion or love. If sex-response is interrupted, anger results; and this may vary from a low level of barely noticeable irritation, with very slight unpleasantness, to an opposite extreme of almost wholly thwarted sex, expressed by angry bodily action of great violence, and retrospected, variously, as "slightly" unpleasant and "intensely" unpleasant. Certainly there is some stage or particular sort of anger, with every human subject, that is reported as intensely disagreeable; but the environmental situation under which this most unpleasant anger occurs varies widely with the individual subject. The opinion seems to be unanimous, more-

over, that no type of anger is as unpleasant as is fear of comparatively slight intensity.

Since female organisms contain mechanisms for bodily depletion of three types, menstrual, reproductive, and mammary, not active in the male, and since all of these female depletion-functions are closely associated with, and dependent upon, the activities of the genital organs, it would be natural to suppose that the self-depletion type of response from sex-stimulation would occupy a much greater proportion of the total behavior of females than of males. The result of this more frequent self-depletion behavior, in turn, should be a much more deeply inwrought form or pattern for motor setting directed toward self-depletion, than in the case of male organisms. That this is the case, the relations existing between men and women, from the beginning of history to the present century, amply testify. The mere fact that woman is physically weaker than man, whether this be regarded as a cause or as a result, can never account for voluntary acceptance of a subservient or submissive relationship, unless actual will-settings, or motor responses of a submissive character, had been developed. Such female responses have been built up, I suggest, as a result of the three self-subjecting and self-depleting mechanisms, above mentioned, which form no part in the functional complement of the male organism. No additional type of emotional response, or "instinct," seems to me to be necessary to explain the female's reaction toward her offspring. It is simply a self-depleting type of will-setting, of a true sex-character, which has become conditioned upon the progeny as effective stimulus, mainly through the exercise of the two special female self-depletory mechanisms concerned with the birth and nourishment of offspring.

Male animals, and male human beings, are, I believe, preponderantly appetitive in their total behavior. Lacking the above considered mechanisms for self-depletion which are possessed by the female, and possessing a type of sex-reflex mechanism which leads to much more rapid consummation of the sex-purpose of self-depletion than is the case with the female organism, the proportion of male responses directed toward sex-ends is necessarily minimized. Taking into consideration only the time consumed by the mechanical factors involved in an act of coitus resulting in conception and birth of offspring, it can readily be seen that, whereas the male act of self-depletion is completed in a few minutes, the female response is not completed for nearly two years, including pregnancy, giving birth to the offspring, and nourishing the latter throughout its embryonic as well as its early infantile existence. Throughout this long series of psychophysiological reactions which can, I suggest, be treated as a single, typical, female sex-response, every item of

behavior involved follows the uniform sex-pattern of self-depletion. It is not surprising, therefore, that, in the female organism, the will-setting type of self-depletion is even more deeply inwrought, after the experience of maternity, than is the appetitive response-pattern of self-enlargement. Lacking these female depletion-functions, however, the male organism often possesses such a poorly developed sex-response that the resulting reaction toward the female is a predominantly appetitive or dominating one. Such domination, which is identical whether directed toward mate or food, has probably led, in a literature largely written by men, to the common error of referring to the sex-response as an "appetite," whereas, it seems to me, it might better be called a "feeding." As a matter of fact, once the sex-relation is actually established, the female body is the one built to dominate or surround the male sex organ; and the female body is the one enlarged, at the consummation of the act, at the expense of the male organism. Biologically speaking, therefore, we might well say that the male's sex-behavior is directed toward depleting himself for the benefit of the female, while the female's sex-response is directed toward depleting herself for the benefit of the offspring, or the race. Such a statement holds true, also, of secondary human sex-conduct in so far as the husband furnishes economic support to his wife, and the wife "brings up" the children. If any distinction were to be drawn, therefore, between the degrees of objective dominance actually attained in the sex-relationship between male and female, it would seem to be the female who is the more dominant, despite the appetitive dominance of attitude carried over, by the male, into his sex-response. Psychologically, however, both male and female will to deplete themselves for the benefit of the other, in so far as the relationship constitutes a mutually effective sex-response; the female responds even more strongly toward the offspring; and, in some cases, the male may succeed in conditioning some part of his reponse, also, upon the progeny as effective stimulus.

In human sex-behavior, however, both men and women frequently carry over certain aspects of appetitive response into their sex-relationships; and this phenomenon seems to be traceable directly to the factors of the male's predominance of appetitive development, and the female's biological and economic enlargement by the male, considered above. The male may, if he so elects, assume a dominant attitude toward the female, as he does toward his servants, or other appetitive objects; but he can not avoid depleting his organism if he responds, sexually, to the female as a sex-object. The human female, on the other hand, has found means for dispensing with ultimate self-depletion in carrying out her sex-response with a male, by the simple expedient of preventing conception; and, similarly, she can enlarge herself, economically, at the expense of the male, without any correspondingly completed self-depletion. But, on the other hand, she can not avoid self-subjection, or submission to the male's appetitive dominance, if she succeeds in making herself a sex-object or stimulus to

him; for only by virtue of expressing this initial phase of self-depletion can she differentiate herself from statuary, furniture, or servants as a true sex-object rather than a wholly appetitive one. This frequent mingling of opposite phases of sex and appetitive response in human behavior becomes still clearer in light of an analysis of the two phases of the completed sex-response, which we shall now attempt.

Like appetite, sex-response seems to divide itself, naturally, into passive and active phases, or parts, quite distinct the one from the other. Whereas the active phase of appetite occurs first, however, the order is reversed in the sex-behavior pattern. No real sex-activity can begin until the subject is accepted by the sex-object. The process of seeking, and getting the self accepted by the sex-object may be, and indeed usually is, an exceedingly active one, physically; just as a person after procuring his food may exhibit considerable physical activity in eating it. But during this initial phase of sex-response, as during the final phase of appetitive behavior, the subject remains, primarily, the object acted upon, rather than the moving, or controlling agent. The man who is seeking marriage with a woman must please her in diverse ways; and, in such case, he is submitting his own tastes, time, and activities to the dictates of the sex-object. Similarly, if the situation is reversed, the woman dresses and behaves in the way in which she believes her lover wants her to dress and behave; and her throwing of difficulties in the way of his suit merely constitutes a recognition of his predominantly appetitive male development, which demands continual stimulation by opposition to arouse dominance. In both cases the sex-subject obeys the dictation of the desires and needs of the sex-object; and is, therefore, the thing acted upon, rather than the active agent, just as the appetitive subject becomes the thing acted upon when the food he is eating begins to eliminate his hunger pangs. The type of behavior, then, during this passive phase of sex-response may be characterized as *subjection;* and the accompanying phase of sex-emotion emphasized may be termed *passion.* "There is some evidence," says Woodworth,[23] "of a native submissive, or yielding tendency." I submit that the origin of this tendency, which seems to me very clear in the behavior above analyzed, is the passive, or initial phase of sex-response.

The active phase of sex-response begins with the acceptance of the subject by the sex-object, and ends with the consummation of the sexual self-depletion of the subject. This consummation does not take place, with the female, as above pointed out, until after birth and nourishment of the offspring. The female orgasm, however, although not effecting ultimate self-depletion, yet constitutes, in all probability, an act of preliminary self-depletion, corresponding to male self-depletion simultaneously occurring; and it seems certain that the accompanying female

emotional correlate of this active phase of sex-response more than equals that of the male in both intensity and duration. Although the predominant relation of subject to sex-object during this final phase of sex-response is clearly an active one, yet a certain element of passivity or subjection to stimulation by the sex-object remains throughout, since each participant in the act is at the same time depleting himself, by movements directed by himself, and also is *being depleted*, by stimulation administered in movements directed by the sex-object. While the final, characteristic emotional element predominating during this active phase of the response, therefore, might be called *ecstasy*, the distinctive quality of passion seems to remain almost equally strong, if this element was clearly present during the passive or initial phase. These emotional elements in love, or sex-emotion, and the corresponding elements in anger, are constituted, like those associated with the appetitive response, by an *awareness of the relationship between the subject and the end willed, together with the flood of pleasantness (or unpleasantness) flowing from such awareness.*

Sex Response
(Will-setting toward self-depletion)

	Successful	*Unsuccessful*
	Passive	
Perceived relation of organism to sex-object	Subjection	Subjection less successful than rival's
Emotional correlate of such perception	Passion	Jealousy
	Active	
Perceived activity of organism in relation to sex-object	Depletion	Rival in self's place
Emotional correlate of such perception	Love (Passion *plus* ecstasy)	Anger

With this further consideration of the two phases of sex-response before us, we may analyze more clearly the mingling of appetite and sex found in human behavior. Let us take, as an example, the instance where an appetitively developed man mates with a woman whose appetitive behavior-pattern is at least as deeply inwrought as is her sex-response pattern. The woman begins the drama by furnishing to the man a stimulus of unpleasant deprivation, analogous to hunger pangs. She makes herself an appetitive object, suited to his individual appetitive response, in every way she can devise. She adds to this carefully prepared stimulus an element of inaccessibility, which corresponds to the unpleasantness of the stomach-pangs, driving the man to action in order to escape from this unpleasantness. When the female appetitive stimulus has produced, in the man, a will-setting of self-enlargement directed toward that particular object, he begins to take up his part in the play. The man proceeds to pursue the appetitive object by any means suitable; probably a mixture of propitiation and force, submission and dominance. The woman gradually permits her own capture. The man's response thereupon becomes momen-

tarily one of pure dominance; and the true submissive character of the woman's entire response is now frankly expressed. During this initial or passive phase of the response, therefore, we find the man retaining, throughout, a will-setting of unaltered self-enlargement type, and the woman a will-setting of equally constant self-depletion type. The objective and emotional results gained correspond, respectively, with the will-types expressed; the man has gained an appetitive victory, with accompanying emotion of triumph; the woman has won a sex-victory, having obtained the man as her sex-object; and she experiences, presumably, more or less passion accompanying the process of being pursued as well as during her climactic surrender.

At this juncture, however, the rôles are reversed. The woman has gone as far in her sex-response as she intends to go; from this point on, she adopts an appetitive will-setting, directed toward enlarging herself, physically and economically, at the expense of the man. The man, on the other hand, in pursuing and capturing the woman as his wife, has automatically, by that procedure, placed the woman in the position of his sex-object, no matter how appetitive may have been his attraction for her in the first place. In addition to social, mental, and material relations to the woman, the man himself has steadily created a sex-relation, since he could not buy her, like food, but was obliged to pursue her according to the sex-game, the rules of which require submission to the sex-object. Unwittingly, perhaps, but no less surely, he has built up behavior-habits of subjection to a sex-object, and has conditioned whatever sex-response pattern he may possess upon this woman as effective stimulus. When, upon final consummation of the sex-relationship, this sex-pattern leads to an actual will-setting of self-depletion, a true sex-response is developed which, in so far as it may control the man's conduct, can be utilized by the woman for her enlargement at his expense. Again, each type of will-setting has attained its given end, objective and emotional; the woman gains luxury and ease, and experiences accompanying mild elation, following the removal of the unpleasantness of want; the man, if a sufficient proportion of his activity is devoted to depleting himself to the woman, gains her as his sex-object, and feels an accompanying emotional correlate of love. It is seldom, however, that an appetitively developed male continues to respond to a female after she ceases to behave sexually toward him, since the building up and conditioning of a sex-response pattern which he accomplished, unconsciously, while pursuing the woman from an appetitive motive, is apt to break down almost immediately upon the woman's ceasing to shape her action with reference to his native response-mechanisms.

The foregoing analysis shows, I think, that although sex and appetitive responses may alternate in human relationships between male and female, the two types of will-setting, with their emotional accompaniments, remain, in each case, distinct and opposite in procedure and result. The cat feels no passion for the mouse with which it plays, and no more does the appetitive man feel passion for a woman in proportion as he dominates her; each feels triumph, only, as conscious correlate of willed dominance over captured prey. But the man who succeeds in dominating a woman, may also become submissive to her beauty and charm as a sex-object; and, in proportion as this subjection of the dominant male alternates with or supersedes his dominance toward the woman, he will feel passion. Similarly, the mother animal suckling her young is not led to this act by a motor setting toward the offspring identical with her motor

setting toward her food, but rather by an inwrought behavior-pattern exactly opposite in type and result. The human mother, in caring for and nourishing her child, has no possible purpose of self-enlargement, and, therefore, expresses the purest type of sex-response possible to human subjects.

Sex-emotion, or love, contains no admixture of unpleasantness, as does the entire active phase of appetite. Moreover, sex-response attains, at its consummation, a pleasantness more intense and pervasive than that accompanying any other type of behavior. If, as the present theory suggests, this intense and unalloyed pleasantness of affect is the conscious correlate of voluntarily submissive and self-depleting activities, the practical result is to furnish a simple psychological proof of the Christian maxim: "It is more blessed to give than to receive."

(*3*) *Pleasantness and Unpleasantness*

During discussion of the inherent mechanisms of appetite and sex, I offered the suggestion that the general principle of escaping the unpleasant and seeking the pleasant was to be found within these primary mechanisms. Review of the appetitive response, above, discovered that its basis is laid in attempted escape from unpleasantness; and similar consideration of the sex-response has shown, I believe, that its basis is the seeking of the pleasant. Since the initial hunger pangs setting off the first human appetitive response occur during the first few hours of life, the psychophysiological principle of unpleasantness upon which their potency is based must be inherent in the infantile organism. The proof that pleasantness is likewise congenital is not so conclusive. We have no definite means of knowing that the taking of nourishment by an infant organism is accompanied by pleasantness of affect, although we are assured by its resulting change in behavior that the unpleasantness of internal stimulation has ceased. However, some inherent mechanism for unpleasantness, at least, must be discovered, if we are to explain the apparently congenital affect of hunger pangs.

Unpleasantness

From the above analyses of fear and anger, we derive the conclusion that both of these complex emotional states are correlated primarily with conflicts of motor impulses, somewhere within the nervous system, at levels accompanied by consciousness; and we found that both these emotions are strikingly unpleasant. Of the two, fear was found to be more unpleasant than anger, and was similarly found to be correlated with a more fundamental type of motor conflict. These analyses suggest, to begin with, that some relation may be found between conflicts of motor impulses within the nervous system, and the accompanying feeling of unpleasantness.

Affective abnormalities resulting from lesions of the lateral zone of the thalamus have been studied, with striking results, by Head and Holmes.[24] They found that the most important feature, in the 24 cases studied, was an excessive response to affective stimuli. The pleasurable affect of warmth, for instance, was found accentuated, on the injured side, with no lowering in the sensory threshhold; while tickling, and other normally indifferent or mildly unpleasant sensations became very unpleasant. The body was found to react more extensively and more vigorously to affective stimuli in all cases. In short, these investigators have shown that over-reaction is associated with exaggerations of pleasantness and unpleasantness.

My preceding analysis of fear attempted to show that efferent impulses, flowing from sensory stimulation of the organism by a dangerous environment, were competing, within the nervous system, against antagonistic motor impulses directed by a central setting, or will-image, for control of a common efferent path. My analysis of anger postulated a struggle or competition between two groups of motor impulses which might be characterized, in the phraseology of H. E. Hering,[25] as "pseudo-antagonists," or efferent impulses simultaneously utilizing a "final common path" to produce somewhat opposed muscle movements. This pseudo-antagonism of motor impulses, therefore, is much more peripheral than is the true antagonism of fear, and the accompanying unpleasantness is found to be of a much more superficial and sporadic nature. The most fundamental type of unpleasantness, on the other hand, and that of most uniform persistence, would seem to be that state of fear where the competing impulses are of almost equal strength, producing an alternation in control of their common motor path, resulting in trembling of that part of the body or limbs innervated. In the light of this correspondence between the nature and intensity of competition or antagonism between efferent motor impulses having a final common path, and the nature and intensity of the accompanying affective state of unpleasantness, I venture to suggest that the increased unpleasantness of sensory stimulation, found in the results of Head and Holmes, was *caused by* the increased intensity and volume of efferent impulses, due to release from the inhibitory influence of the cortex, which were available to compete against existing motor impulses for control of the common efferent paths. Motor antagonism, in short, seems to be the neurological accompaniment of unpleasantness. In thalamic lesion cases, there was greater volume and intensity of efferent discharge from sensory stimulation, as indicated by increased extensity and vigor of bodily reaction. There was, therefore, greater intensity and duration of motor conflict, wherever antagonistic

impulses were brought into competition for control of the final common path. Moreover, with the removal of cortical coordinations, a larger number of such antagonisms might be expected to occur, since many allied, or pattern groups of impulses would necessarily become disconnected with the removal of their cortical termini. This would tend greatly to increase the proportion of unpleasantness in the total affective accompaniment of sensation, which was, in fact, the precise result reported by Head and Holmes.

If, then, we define unpleasantness as *the conscious correlate of motor antagonism between impulses or groups of impulses seeking outlet over a common efferent path*, we find, according to Sherrington, that such antagonisms may occur between spinal reflexes[26], or between reactions elicitable from the motor cortex[27]. There seems to be no good reason for limiting the definition of unpleasantness to the cortical antagonisms; and, in fact, there is considerable evidence against such a limitation. It was long ago demonstrated that only thalamic connections are necessary to spontaneous movements, and to the "instincts" of appetite and sex[28]; and this work has subsequently been verified and extended[29] to such a degree that an inference of affective accompaniment of thalamic activity is plain. On the other hand, these results also show, as does the work of Head and Holmes above referred to, that the thalami are necessary to the presence of affective accompaniment of sensation, as well as to spontaneous movements in pursuit of food or sex-object. It would seem, therefore, that affective tone is an actual accompaniment of sensation, since the thalamic sensory centers are necessary to the existence of pleasantness and unpleasantness; but, if the above analysis is correct, the blocking or competing of impulses must occur in the neurones of the cord[26], or in still more peripheral neurones of the "final common path"[25]. We have, then, a competition of two or more motor impulses in the cord, with partial or complete blockage of one of these impulses inevitably resulting; and we have an accompanying feeling of unpleasantness associated, consciously, with the sensation accompanying that sensory impulse which wins through to motor expression.

There seems to be good authority for the assumption that any impediment to normal discharge of any definitely elaborated nervous circuit is unpleasant.[30] We find ourselves, however, in the predicament of supposing, if the foregoing theory be adopted, that the competition of impulses partially blocks the motor discharge of the victorious sensory impulse, if the accompanying unpleasantness is to be attributed to any stasis in the nerve centers, or unrelieved summation of stimuli in the successful impulse path. This, we know, need not occur, since the bodily responses to unpleasant stimuli, in the thalamic lesion cases,

were over-reactions, indicating that the successful motor impulses were not in the least reduced, either in volume or intensity, by competition with antagonistic impulses, if such competition had occurred as I have supposed. There remains the possibility that *unpleasantness is correlated with unrelieved, thalamic, summation of sensory impulses, in the sensory circuits of the unsuccessful competing impulses.*

This conclusion has the advantage of removing that element of mystery which remains if we suppose that affective tone is somehow inherent in the sensation which is felt as unpleasant. Almost any sensation may be pleasant or unpleasant, under differing environmental stimulations, and differing motor sets of the organism. Moreover, the same sensation may change its affective tone, abruptly or gradually, with no discernible alternation in sensory stimulation, or in bodily reaction. Again, it is by no means true that unpleasant sensations are less vivid, intense, or enduring than pleasant ones; and if any change in the resistance or nervous energy in the path of the impulses accompanied by unpleasant sensation occurred, correlated with its unpleasantness, it is almost inconceivable that there should be no corresponding change in the inherent qualities of the sensation above mentioned. If, on the other hand, the unpleasantness is correlated with a piling up of unreleased nervous energy in an entirely different sensory circuit, no complication of known sensory mechanisms is necessary for its explanation. The successful sensory impulse blocks its rival. The defeated rival impulse piles up in its thalamic path, without motor outlet. The denial of motor outlet deprives the defeated sensory impulse of any discernible sensory quality, since the intensity of the impulse passes above the thalamic threshold of sensory sensitivity. And the resulting over-intense thalamic activity is accompanied by a vague abnormality of sensory awareness, which we term "unpleasantness."

Applying this suggested mechanism of unpleasantness to our problem of initial appetitive response, no argument need be adduced to prove its inherent character. Any unrelieved summation of sensory stimuli in the infantile thalami will be immediately felt as unpleasantness. Hunger pangs may be supposed to set up sensory impulses of much greater intensity than those resulting from environmental stimulation, since the peripheral sensory end-organs are not yet completely sensitized, and the other portions of such sensory circuits may be supposed to be similarly in a state of incomplete development. Even if the stomach pangs do not produce pain, the resulting sensory impulses, predominating in volume and intensity over other groups of impulses simultaneously obtaining in a normal infant, may be expected to deprive these other impulse-groups of

their proper motor outlets, wherever common efferent paths are involved. Although the extent of such motor competition might well vary considerably, in individual cases, as environmental and internal stimulation must vary with different infant organisms, yet it is difficult to conceive a normal case where insufficient motor conflict would be developed, as a result of hunger pangs, to cause the unpleasantness necessary to initiate the appetitive response.

Given inherent hunger pangs, of inherent unpleasantness, the tracing of the final course of the adult appetitive response becomes a simple matter. A behavior-pattern is gradually formed, as a response to the unpleasant stimulus, directed toward obtaining and eating food, as heretofore outlined. When the food is obtained, its sight, smell, and taste add positive, sensory impulses to the organism's existing complement. These sensory impulses find motor outlet in the cranial autonomic, and the result of this motor discharge is to start gastric digestion, and to abolish the stomach contractions set up by the chemical hunger-stimulus.[14] With the cessation of hunger-pangs, these sensory stimulations caused by the pangs similarly cease, and the supposed motor conflict set up between these sensory impulses and other existing sensory impulses, for common motor outlets, which was found correlated with the initial unpleasantness of the appetitive response, also ceases.

Thereafter we found, in the foregoing discussion of appetitive response, that positive pleasantness began to accompany the food sensations, as the subject continued to eat. If the infant, in the consummation of its first appetitive response, experiences this pleasantness, a congenital basis for pleasant affect must be sought, as well as the inherent mechanism for unpleasantness which I have attempted to suggest. As above pointed out, there seems little positive evidence one way or the other upon this issue; but it may be assumed that an hypothesis for pleasantness which discovers a mechanism capable of operation during the initial appetitive response of the organism will better meet the logical possibilities of the situation than a theory which supposes a later development of nervous response correlated with pleasantness of affect.

Pleasantness

In the foregoing analysis of the appetitive response, we found that positive pleasantness was not felt until after the hunger-pangs had been abolished. It would be futile to suppose that no taste, smell, or visual sensations from the food eaten penetrated the consciousness of the organism previous to this cessation of hunger, especially as we know that the motor impulses flowing from such sensations play an important rôle, through

their vagus efferent channels, in the abolition of the stomach-contractions. Yet it appears equally certain that the ravenous consumption of ordinarily disagreeable and even indigestible materials [31] cannot be accompanied by positive pleasantness, although such eating and swallowing may temporarily suppress hunger. Two important inferences may be drawn from these well established facts: first, that pleasantness cannot be felt, under the circumstances considered, as long as a condition of unpleasantness prevails; and secondly, that pleasantness appears correlated with identically the same sensory stimulations which were felt as indifferent while unpleasantness obtained.

It will be remembered that, in the results of Head and Holmes cited above, greatly increased pleasantness was found accompanying certain warmth-stimulations of medium or minimal intensity. The sensory threshold was not materially lowered. We may assume, therefore, that the over-reactions following such warmth-stimulations are not to be correlated with increased sensory awareness of warmth, as a distinctive quality of sensation, but rather with the affective state of pleasantness which accompanied the stimuli. Since the intensity of stimulation was low, as contrasted with the greater intensities of stimulation correlated with enhanced unpleasantness, considered above, and since the threshold for sensations of warmth is continually readjusted to the "physiological zero" of the body,[32] we may suppose that the principal result of removal of cerebral inhibitory influence by the existence of a thalamic lesion was to permit a greater number of subminimal stimuli to win through to motor discharge, rather than to make possible the delivery to effector organs of a greater total intensity of motor impulse accompanied by actual sensations of warmth. Sherrington[33] has proved that subminimal motor impulses, unable to evoke a given reflex, when conjoined with other subminimal motor impulses from sensory stimulation of another receiving organ, having a common efferent path, suffice to evoke the reflex in question. This mutual reinforcement of certain spinal reflex arcs gives rise to the term "allied reflexes;" and Sherrington finds similar "allied" groups of sensory arcs at the motor cortex[27].

By the "all-or-none" law[34] we know that grading of neural activity by action of the synapse does not occur. We may, therefore, conclude that the same subminimal intensity of such sensory impulses obtains in the thalamic centers as that which is finally discharged into the effector organ, provided the nervous circuit involved passes through the thalamus. In the instance of sensations of taste, smell, and sight of food, as well as in the cases of abnormally pleasant sensations of warmth following thalamic lesion, we know that the sensory paths involved include thalamic units. I suggest, therefore, that *the passing of*

any subminimal sensory impulse to unimpeded motor discharge, over any thalamic nerve path correlated with consciousness, is accompanied by the feeling of pleasantness.

In the case of pleasant food-sensations, above considered, we found that the principal sensory qualities of taste, smell, and vision were probably present during hunger; but we also know that the subtler discriminations of taste and smell are not present in consciousness when an exceedingly hungry man sits down before a hearty meal. Sensory stimulations of low intensity, arising from slight decay of food substances, or from improper cooking and preparation of foods served, fail to register in consciousness while hunger persists; and we may assume that this result is due to the inhibition, or blockage from motor discharge, of such sensory impulses by the antagonistic hunger-pang arcs. Similarly, we find additional pleasant food-sensations present after hunger is eliminated, besides the adding of pleasantness to those major qualities of sensation which accompanied the eating of the first mouthful. The pleasant sensations of which the subject is newly aware arise, altogether, from visual, gustatory, and olfactory stimulations of low intensity, which failed to win through to motor outlet while the strongly opposed efferent impulses from the hunger-pang sensations persisted. These facts suggest that, with the cessation of antagonistic innervation, many sensory impulses which were previously blocked from motor expression pass the efferent threshold, and make their respective qualities felt as true sensations. As eating is continued hereafter, the pleasantness accompanying any food-sensation which can actually be distinguished increases steadily, up to the end of the meal; but the qualities of food-sensations tend, gradually, to become indistinguishable, owing both to fatigue of sensory organs and to other causes. Pleasantness usually continues, however, as long as food is eaten, and even after the subject has left the table a vaguely pleasant affect remains, unaccompanied by definite sensations.

We noted above that pleasantness seemed to be excluded from consciousness by unpleasantness. The mechanism of such exclusion now becomes evident. While blockage of any considerable portion of the efferent path continues, many sensory impulses, both allied and antagonistic as between themselves, and normally of sufficient intensity to pass the motor threshold, are blocked by the more intense efferent group which is antagonistic to all vagus discharge. Simultaneously, then, any existing subminimal food-stimuli must be cut off, by the hunger pangs, from motor outlet. Therefore, if the above suggested definition of pleasantness be accepted, all that free flow of subminimal impulses with which it is correlated is in abeyance, and no pleasantness can occur as long as the major antagonism, or unpleas-

antness, continues. Once the full flow of vagus motor discharge is released, however, by the abolition of hunger-pangs, a continually increasing openness of motor path for allied subminimal impulses may be expected; and that such impulses exist is indicated by the continuation in augmentation of the flow of gastric secretion,[35] after actual food-stimulation of appropriate sensory organs has ceased. This augmented flow of gastric juice continues, in animals, from 15 to 25 min. after the conclusion of an appetizing meal; and Carlson[36] found, in a human subject, that the maximum gastric secretion occurred during the eating of dessert. Such determinations of the quantitative aspect of vagus motor discharge correspond with the accompanying pleasantness of affect, but not with the intensity or extensity of qualitatively distinguished food-sensations. It seems fair to assume, therefore, that both gustatory and olfactory stimulations of insufficient intensity to pass above the thalamic threshold of sensation may, nevertheless, find motor outlet through the aid of their "alliance" with those sensory stimuli giving rise to qualitiatively differentiated food-sensations, as long as these persist; and that, for as long a time thereafter as the chemical stimulation of gustatory and olfactory end-organs continues, such subminimal sensory impulses may find common motor outlet through "alliance" between themselves. During the first period, then, while food-sensations are clearly distinguished, it is these sensations which are felt to be pleasant; but after there remain no individually differentiated sensations to which pleasantness may be attached, those subminimal sensory impulses which are still finding unimpeded motor outlet are merely accompanied by that "diffused unlocalized affective experience of well-being"[37] which is the essence of pleasantness. I would describe this experience of well-being, more specifically, as *a cumulative, harmonious, sensory awareness accompanying allied discharge of sensory impulses of insufficient intensity to pass the lower thalamic threshold of sensation.*

The pleasantness which we found as a constantly enhanced accompaniment of successful sex-response, in the foregoing analysis, may similarly be attributed to a cumulative volume of subminimal sexual sensory stimuli, having final common paths of sacral and lumbar motor outlet, first toward the external genitals, and finally, at the consummation of the response, to those portions of the internal genital mechanism concerned with ejaculation. Since the sex-response begins with pleasantness, we must seek some source of subminimal sensory impulses in the initial internal stimulation. Such is exactly the type of sensory impulses which the initial internal sex-stimulus might be expected to produce, since the distribution of the action of this hormone seems to be very diffuse, and the stimulation at no time

distinctly localized. No single sex-sensation can be differentiated, during this period of internal sex-stimulation, as far as can be judged by the introspection of human subjects; but there is apparent in the behavior of both human beings and animals an increase of general bodily activity, with a distinct tendency toward typical sex-movements. This result would be precisely that expected to ensue upon mutual reinforcement of subminimal sex-stimuli sufficient to obtain motor outlet; and would, according to the theory above suggested, be accompanied by pleasantness.

As the sex-response proceeds, its correlated pleasantness increases cumulatively, up to the final consummation of the act. During this period we find a continually repeated stimulation of the same sensory end-organs, with a perfectly identical type of motor discharge, over common paths, from all the sense organs stimulated. While the psychical sex-elements and the pleasantness of affect are piling up, therefore, the sense-organs are undergoing steadily increasing fatigue, which must result in a progressive rise of the sensory thresholds. Distinctive sensation-qualities may be expected to diminish, then, in exact proportion as subminimal sensory impulses increase in volume. The unbroken alliance between great masses of such impulses, over common efferent paths, ensures unimpeded outlet for the entire group. A conscious correlate of cumulative pleasantness would, therefore, result, as long as sufficient intensity of impulses remained to keep open the common motor outlet. It is this affective element, I suggest, rather than increased intensity or number of erotic sensations, which forms the basis for that cumulative aspect of the sex-response upon which it must depend, reflexly, for its consummation.

The involvement of the cortical centers, also, with still further reinforcement of sacral-lumbar discharge, would seem to depend upon the affective volume accompanying the stimulation, rather than upon the intensity of the stimulation, although this must be constantly maintained at a sufficient intensity to secure the common motor outlet. If the intensity of stimulation of individual sense-organs is increased too greatly, the ensuing thalamic impulses must pass over the threshold of qualitative sensory sensitivity, once more, and the subminimal sensory discharge will be correspondingly diminished. If sensation is thus increased at the expense of pleasantness, central psychical reinforcements of any pleasant response are apt to drop out, in proportion. In short, the foregoing theory of pleasantness would indicate that the attempt to increase pleasure by increasing the intensity of sensory stimulation is not only futile, but actually militates against the end sought. This result, I believe, is a very common one in every-day experience.

Finally, pleasantness must turn to indifference (*a*) if the subminimal sensory impulses which are its true correlate cease; (*b*) if the motor discharge of that sensation which makes possible the outlet of the subminimal impulse is transferred to a foreign channel; or (*c*) if stimulation producing such essential sensation is stopped. The first contingency occurs in the instance cited above, where over-intensity of stimulation eliminates a portion of the total subminimal sensory activity. The second change of pleasure to indifference may be exemplified by the cessation of aesthetic response to any object of art, under pressure of material necessity, and the subsequent use of such object to serve a physically active end. The relationship of "indifference" which thereafter exists between the principal group of sensory impulses stimulated by the object, and the subminimal group which had been furnished with a motor outlet before the change of response occurred, is found by Sherrington[28] to exist as a standard type of motor organization, both in the cord and at the motor cortex, wherever two efferent impulses, or groups of impulses, are discharged over wholly separate and unrelated final paths. The third type of shift from pleasantness to indifference is to be found in any instance of ceasing to look at a "beautiful" object. The sensory stimulation which produces the impulses serving to open a path of discharge possessed, in common, by such stimuli and an existing subminimal group is cut off; and the pleasantness simultaneously ceases, though its true sensory neurological correlate was not to be found, at any time, in stimulation by the object thought of as "beautiful" or "pleasant". Thus indifference takes its place, in contradistinction to both pleasantness and unpleasantness, as a term denoting that affect-less state of the organism's awareness obtaining whenever the controlling groups of sensory impulses are able to find simultaneous motor outlet without passing over a final common path.

Affective States

	Positive	*Negative*	*Neutral*
Name of affect	Pleasantness	Unpleasantness	Indifference
Sensory content	Awareness of free, harmonious, sub-sensation	Awareness of blocked, disruptive, super-sensation	Qualitatively differentiated sensations, only
Correlated relationship of motor impulses	Allied in final common path	Antagonistic in final common path	Unrelated, with separate final paths

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AN EXPERIMENTAL STUDY OF THE AFFECTIVE QUALITIES[1]

By JOHN PAUL NAFE

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INTRODUCTION

We undertook this Study on the assumption that the affective qualities, whatever they may be, must be palpable. It is true that the Würzburg School have sought to introduce into experimental psychology a whole group of impalpables; and it is true, more particularly, that many psychologists have been led, by the results of experiment, to recognise impalpable affective qualities. Yet the continually recurring attempt to identify simple feeling with organic sensation shows that there is a strong current of expert opinion running in the opposite direction. The presence of impalpables in a scientific subject-matter is, indeed,— unless one is ready, with Brentano and the Würzburg School, to define science *ad hoc*,—anomalous, if not contradictory. We decided, therefore, to show the courage of our scientific convictions, and to assume that the affective qualities are palpable.

We thus planned a new frontal attack upon the psychology of affection; and the first thing to do, in working out a technique, was to study the methods of our predecessors. It seemed possible that the diversity of result and of opinion in affective psychology might be due, largely, to some single error of procedure, —to some very natural error that had been passed on, in varying

[1]From the Psychological Laboratory of Cornell University.

degree, from investigator to investigator. We therefore read with an eye to this possible error: and we found something which, if not universal, is at least widespread, and which gave us the needed cue to our own procedure. We thought we found that most experimenters upon affection had made their observers *feelers* rather than *observers of feeling*. They had tried, very naturally, to arouse strong feelings; and by this natural endeavour had, nevertheless, defeated their own object.

Let us take an analogy. Everyone will grant that it is impossible at one and the same time to work hard upon an intellectual problem and to observe the existential processes that underlie the attempt at solution; it is impossible to 'do two things at once,' the exercise in applied logic and the exercise in psychological observation. An experimenter in such case must have recourse to interruption and fractionation, and even so must cut his problems with all care to suit the competence of his observers. The same thing holds of emotion: we cannot both be angry with somebody about something and at the same time observe our anger; and this inability is (on our hypothesis) not due to the impalpable character of the affective core; it is simply, again, the inability to 'do two things at once.' But every strong feeling, set up in an experimental context, tends to be emotive or transcendent; the more effective the stimulus, the more likely is it that the observer becomes frightened, or offended, or amused, or captivated. More than that: when once the error of transcendence has crept in, it will influence the observer's general attitude; the less effective stimuli will still arouse mild emotion.

Here, therefore, we seemed to find a very general source of error. It looked, in fact, as if the error of transcendence in affective work might be as harmful as the stimulus-error in psychophysics. We decided accordingly not to make our observers into feelers; not to try to overwhelm them with feeling; and, especially, not to allow them to become timid or anxious about what was to befall them in the experimental hour. We decided to employ simple stimuli of moderate intensity, such as might be expected to set up affective qualities of moderate intensity, which the observer should then observe and describe as equably as he had been accustomed to observe and describe sensory qualities. Feeling must be aroused,— but feeling as existential process, not as referred emotion.

We may anticipate our detailed statement of method and results by saying, at once, that the plan which we adopted has led us to a definite conclusion. The affective qualities, pleasantness and unpleasantness, turn out, under direct observation, to be modes of pressure: *pleasantness is a bright pressure, and unpleasantness is a dull pressure.*

Observers. Our *Os* were Dr. L. B. Hoisington (H), a member of the instructing staff, with about eight years' experience in observing in psychological experiments; Dr. H. G. Bishop (B), also a member of the instructing staff, with about eight years' experience in observing; Dr. Grace K. Adams (A), a graduate student at Cornell University at the time of this work, with three years' experience in observing; Miss Elizabeth Mŏller (M), Mrs. John P. Nafe (N), Mr. S. Feldman (F), Mr. F. L. Bixby (By), all doing graduate work in Psychology and all with some previous experience in observing; and Miss Mary Brown (Br), an undergraduate student who had taken the first two courses in Psychology at Cornell University and was, during the time of her observations in this experiment, taking a course in Experimental Psychology. Br was without previous experience.

We thought, at one time, that we could arrange our *Os* in a sort of order of rank, by noting the date of their first positive reports; but on going over the reports, after the conclusion of the experiments, we found that the arrangement was not possible. There are hints of what is coming, for most of the *Os*, in their early reports; but even after a positive report had been given, there were 'relapses' in several cases. F, at the end of his third week, gave as complete a single observation as he ever made subsequently; yet, between that and the next positive report, six weeks elapsed. H and Br, on the other hand, gave positive reports from the first and, especially in the case of H, never faltered. Most of the others worked into the problem gradually, and progressed steadily to the end of the series.

An exhibition of the course whereby the *Os* all fell into line would, we think, be both interesting and valuable; but short of showing the whole series there is no way to bring out the facts; and for that, of course, we have not the space.

Stimuli. The stimuli used, and the catch-word which represents them, are as follows.

Visual: (colored strip) a series of colors painted on a strip of paper, B through R to Y, with three intermediates between B and R and three between R and Y; (flicker) a flicker produced by rotating a disc, half W and half Bk, of 9 cm. diam.; (foetus) the foetus of a dog in a bottle of alcohol; (opal) an opal on a background of beeswax; (citrine) a cut citrine, also presented on the beeswax. The uniform time of stimulation was 5 sec., unless the *O* fulfilled instructions earlier, in which case he ceased looking at the stimulus and began his report.

Auditory: (chord) four forks, C, F, A, C′, struck in the order given with a very light blow. The chord was allowed to continue for about 3 sec., and the forks were then damped in the same order; (loose fork) a screw-fork with the screw loosened. The fork was struck rather violently, and produced a rattling, grating, tone. It was sounded for about 1 sec.

Olfactory: (most of these stimuli are solutions or oils,and were presented in bottles) caryophilline, sweet orange, vanillin, rose geranium, bergamot, jasmin, wormwood, ammonium valerianate, mustard, asafoetida, glue, pyridine, dead flowers, fish soap, apiol, tansy, guiacol, juniper, citronella, the juice from a can of shrimps, and some crackling. We instructed the *Os* to breathe normally. The uniform time of exposure was the time of one inhalation.

Gustatory: sweet chocolate, vinegar, salt solution. There was no control over the time of stimulation. Small amounts were used; in the later experiments one drop of vinegar or salt solution from a camel's-hair brush, or a very small piece of the chocolate.

Tactual: (hot steel) a piece of steel, about 1 in. in diam. at the contact surface, heated to about 50° C; (cold steel) the same piece of steel chilled to about 1° C; applied, in either case, to the volar side of the forearm for 4 sec.; (egg) an egg warmed to about 40°C., rotated in the palm of *O*'s hand for 4 sec.; (fur) a small strip of very soft fur, 12 cm. long, set on the

side of the *O*'s neck and drawn slowly and evenly across it; (glass) a smooth bit of glass moved over the tips of the fingers; (sandpaper) a piece of No. 0 sandpaper, reinforced by a piece of wood, moved across the finger tips; (eraser) a felt eraser, well filled with chalk dust, moved across the tips of the fingers; (needle) a needle pushed about 1 mm. into the volar side of the forearm, never violently; (wool) a piece of heavy wool cloth against which the *O* was instructed to grit his teeth; (string) a piece of heavy string with a somewhat frayed end which was moved across the lightly closed lips of the *O*.

Instructions. The first instruction given was as follows: "I shall give you a stimulus which is intended to arouse either a pleasantness or an unpleasantness. You are to direct your attention, as exclusively as possible, to the affective side of the experience. When you judge that the feeling is at its maximum, break off your observation and give as detailed an account of the feeling itself as you can."

It was soon found, from the reports, that at least some of the *O*s, in the fear of some painful experience, could not maintain a receptive attitude toward the experience aroused, but satisfied themselves as to the nature of the stimulus before they began their observation. The effect of such an attitude is discussed in another place. It is enough, here, to say that it was found advisable to change the instruction to read "to arouse either a *moderate* pleasantness or a *moderate* unpleasantness," etc.

The final version of this instruction was given after the series with the first four *O*s had been completed and the second group was beginning. It read as follows:

"I shall give you a stimulus which is intended to arouse a moderately pleasant or a moderately unpleasant sensory experience. You are to direct your attention as exclusively as possible to the affective side of the experience. When you judge that the feeling is at its maximum, break off your observation and describe the feeling itself as accurately as you can."

The second instruction was as follows: "Continue the effort to get affection palpable under observation for itself. Look for concomitant organic sensations with a view to determining whether affection is simply a meaning laid over these organics."

We also used a few special instructions, which are given with the report of the particular observations.

Procedure. The work here reported was done between October, 1922[1] and February, 1924. There were, at first, 4 *O*s, H, B, A and F, who worked until June, 1923, with the exception of A who was forced to end her observations in April, 1923. F worked also throughout the summer session of 1923. M, N and By worked from September, 1923, until February, 1924. Br observed for only 3 hrs., all within one week, in November, 1923.[2] The others gave 3 hrs. a week during their series. They began with 8 to 12 stimuli per hour; but, as they increased the length of their reports, the number of stimuli used necessarily decreased. The number varied with the

[2]The casual introduction of this *O* calls for explanation. In a discussion with *E* of the results so far obtained in the present enquiry, Dr. Titchener remarked that he had a vague recollection that mention had occasionally been made of pressure in old Laboratory Reports of affective experiments. It seemed worth while to see if an undergraduate student of good observational promise would give results comparable with those of trained *O*s. We therefore had recourse to Br, who knew nothing whatever of the experiment beforehand, and who simply received the instructions given to the regular *O*s. Our choice, no doubt, was singularly fortunate; Br's reports show, nevertheless, that affective observation under our conditions is not specially difficult.

different *O*s. H never took more than 5 and, indeed, almost always 3 or 4; while F usually took 8 or 9.

At the beginning of the experiment we planned to present three of the stimuli which we expected to be U to one that should be P; but we soon abandoned this order in favor of a haphazard presentation. We found no way to determine, in advance, whether a given stimulus would arouse a P or an U experience. Usually, ammonium valerianate will bring a report of U; but at times the report will be P. Usually, jasmin will be reported P, but sometimes U, or, maybe, P and later U. One *O* may find wormwood P whenever presented, while another will always find it U, and yet another may find it to be indifferent. There is a further difficulty with tickles, itches and light pressures. In the case of the string, for example, the cutaneous quality aroused definitely resembled for some *O*s the quality of P; and this state of things might be confusing, especially if they found the cutaneous experience U. Eventually, the haphazard order was sometimes modified at the discretion of *E; e.g.*, after a run of U, a stimulus would be introduced which from previous reports might be expected to be P.

The Mode of Occurrence of Sense-Feelings

H, B, A and F gave fairly detailed accounts of the manner in which these experiences occur. N, M and By gave a few, not very detailed, accounts; and we therefore wrote for these *O*s a special instruction, as follows: "Given the whole experience, can you attend to the affective part exclusively to the neglect of the sensory part altogether?" We soon found, however, that the new instruction did not bring out as complete a report as we desired; and we accordingly reworded it, as follows: "You are to state with absolute precision what happens when you try to attend exclusively to the affection. Does it come so loose that there is no reference to the sensation, or is it tied?" N received the first instruction at her 16th sitting, M at her 15th, and By at his 27th; N received the second at her 19th, M at her 19th, and By at his 28th sitting. Br made no report on this point, and left the experiment before we gave the special instructions.

The *O*s agree that the affective experience comes as a unit, and that only when the pressure described as bright, etc., is present can such an experience be described as P, and only when the pressure described as dull, etc., is present can an experience be characterized as U. Experience may be neither P nor U; but, if it is either, the experience, as a whole, is different. The pressures add themselves to the sensory core and, observationally, the primary experience becomes more vague, less sharply defined, less clear.

With every quoted report we give, in parenthesis, the name of the stimulus, the number of the sitting, and the affective characterization.

Observer H

(Needle 3 U) What it seemed like was a sort of blurring of the sensory experience, a falling off of the sharpness. It may have been just a

matter of attention; as if a thin curtain hung in front of it that blurred it and deadened it slightly. (Chocolate 3 P) I wasn't able to catch the affection at any moment of appearance; I always came upon it there. I believe the experience as a total is different when the affection is present and when it is not. (Wool 4 U) There is something there, given in experience, when the affective state comes in that is more than the bare sensory stuff. (Salt 5 U) It seemed there that I could almost catch the U coming in, almost observe the change in experience. Experience takes on a more or less perceptual character; but it loosens up, loses a good deal of its sharpness; partly in extensity; or in a shift from quality to quality the sharp corners are rounded, the contrasting intensities and qualities are fused a bit more. The whole thing is a little more volumic, or the rarefying gives an impression of greater volume. Toward the end the affection had gone. It seems then that the experience is cleaner cut, more compact, more sharply defined, though the taste quality, as quality, isn't very dense in and for itself. (Cold steel 5 P and U) That experience does change. It livened up and loosened up. It is less compact somehow, less dense, and certainly seems, with P at any rate, to be more volumic, bigger with much less definite boundaries, or less sharply marked differences in the sensory part. With the abrupt shift to U the thing shrinks. (Bergamot 6 P) Watching the experience as a total what I got was a blurring, dimming of the smell, and a general diffuse lot of brightness, a bit like bright pressure. Just a volumic mass of experience, all more or less bound up together including the smell, of ill-defined extent and not very dense. It is as if the smell quality lay a little off to one side of the total volume of experience, as if the smell was not the center of the mass but rather the liveness, brightness, that made up the bulk. Toward the end the whole experience seemed to shrink a bit and was less lively and less P. (Sandpaper 9 U) The affective quality itself forms the core of the experience; or, if not the core, it joins with the sensory quality in making up the core to the experience. For an instant the sensory quality came out quite dominant for attention. The total mass of experience was then different, it lacked something that was there both before and after. (Mustard 9 U) It was as if it were in a pattern of experience alongside the smell quality, though they weren't separated. I'm taking experience as a beaten up pattern; it seems the only way I can get at anything. I've come to the belief that it's largely extent or the volumic part of the experience that holds them together, is the cement. I can't separate them in extent. (Sweet orange 10 P) There was a knowledge that the experience was olfactory in part; not the quality of the odor, but a knowledge that it was an olfactory experience. The odor seemed to be set into a mass of experience which was not odorous in its totality. There seemed to be more in experience than odor, though the two were fused in experience as a total. There is no sharp line between the components. (Vanillin 11 P and U) The experience came slightly U. It was short; and then there was a shift, P and U alternated a couple of times very rapidly; then P to the end. The set was pretty uniformly for the affective side of the experience, but even so I can't say that there was any complete separation. I tried again at the end to hold the same attitude after the stimulus was removed. The P did continue for an appreciable time. There was still a hint of something odorous, though very vague and indefinite. The most illuminating part of the experience was during that rapid alternation of the affective qualities; but even so, I don't seem to get farther. The total impression of that rapid change is very difficult to describe. It gave the general impression of extreme oscillation in the total complex of experience, shifting from quite a voluminous, light, airy complex, in which the peripheral part was dominant, to something deader, duller, less volumic. The odor itself, the olfactory quality and the other dimensions, are more or less beaten up together; I can't draw any sharp line on the extensive side nor intensive that marks off the affective quality

from the other; yet the olfactory experience doesn't fill up the other, it seems localized in a certain region of the complex. This seems sometimes to be rather centrally placed and at other times off to the side. I got a little something like a visual image in the oscillating part, streaks of lighter and darker gray. In the last part of the experience the olfactory part was very weak; there was something like a reflection or a hint of odor, almost as if the P itself was odorous rather than the odor being something there, tangible in experience. (Tansy 11 U and P) The affection came out more clearly as experience, but bound up with the olfactory part. It's curious about the change in the olfactory stuff, how different it comes in its total setting. Certain characteristics of the olfactory experience seem to disappear. The odor quality became generalized. It seemed to take its character from the affective side rather than expressing its own character. (Tansy 12 U) The affective part of the experience seems to be largely one of volume *plus* this sort of laying over, blotting out, mellowing, softening of the odor itself. The affective part seems to maintain itself better than the odor; it drops off or gets weak, but there is a hang-over. The curious thing is that the affection becomes more dominant, and what odor is left belongs to it rather than it to the odor. In common sense it's like a scented affection. (Glass 12 U) When the affection came there was really a change in the total experience, but it still remained a unified complex experience. There is one interesting feature: the affection, somehow, seemed to fuse more intimately with certain aspects of the sensory experience than other aspects. The sensory stuff, while all there together, was as if split apart. The sensory stuff was at all times dominant, coolness and pressure. They stood there side by side more than fused, and the affection fused much more with the pressure than the cool. The cool stood off more or less. I don't know why I always make a spatial reference. It isn't spatial, or it's prespatial. It's the easiest way to describe it. The cold didn't fuse intimately. When the affective part came in there was an increase in the total volume; and although the pressure didn't increase, the increase was a margin put around the other experience, and in the more or less central part of the pattern the affective part did not stand out in any way from the pressure component. It was there for observation only in the fringe that extended around the pressure. (Tickle 14 P?) The great difficulty in trying to describe is separating the sensory and affective stuff. The only thing I can say is that somehow the sensory stuff is more sharply defined, denser, coarser grained, and the affection is finer rained, looser. Also the affective part was pressury at the core, with arms running out that were bright, lively. More an impression of gross motility in the sensory stuff. The affection was more like a background that the sensory stuff played over; and the change was in the background, as if the affection didn't modify the sensory stuff. (Rose geranium 14 P) At no time did the smell become dominant, at no time was it the principal element in the experience. The affection stood out, dominated, seemed the principal item of experience, and the smell somehow belonged to the affection. I could have said, in a general way, the region in the prism to which the smell belonged, but it never became concrete enough for identification. It was loose, diffuse, unnucleated experience,—and there, like the affection. The affection is unnucleated too. Along in the middle there was a tendency for the smell to collect, condense, but it didn't go far. It did shrink in extent and increase in density a little. The total extent of the experience did not vary much. It was fairly volumic and quite loose, rarefied. It had quite a bit of body, shows no grain, practically, and yet there is a something there. I think it is a matter of degree, fine, alive, internally alive, still without any gross interplay or liveness. It is a much refined liveness. I will try another analogy: where the odor spreads over the total extent it was like a colored light, showing up in a grey mist or fog. They interpenetrate a good deal; no sharp boundaries. It is part of the fog but the light changes it. There

was not much change in the density except when the odor changed; there was a greater density in that part. The whole thing in a way is bidimensional and yet volumic: no thickness experienced; whereas the broadness, spread, is given. Certainly it is not comparable to surface. When the smell condensed, it seemed to condense at one point in the total pattern. The whole experience didn't change much. When the affection got more intense it seemed an increased liveliness in the whole thing and a more complete dropping out of the center for smell; it was completely diffuse. The experience had an aspect we should call smell; but it is so beaten up it seems a shame to break it up and call one part affection and the other smell. (Caryophilline 21 P) To begin with the sensory part was specific, concrete and dominant, not objectified. Quite gradually but rather rapidly, the affection came on top. The change from dominant sensory to dominant affective is not step-wise nor instantaneous, but gradual though quick. As soon as the affective part is the important part, the sensory clings to that, and the change is mostly change in the sensation. The affection expands somewhat in extent; quality is just the same; and density, still soft, fluffy, that suggests thickness but I can't say thick; no change here. It changes primarily in attensity, whereas the sensory part seems to fade out, softens up, becomes texturally more like imagery without contour; so that it melts in, is more intimately fused with the affective thing, and yet stays qualitatively different, though beaten up. One can still say the two qualities are there, but the affection becomes the matrix that holds the qualities, whereas in the first part there are two matrices. Then in the first part they are aways given there together, yet distinct. The character of affection is the prominence of the peripheral part rather than the central part. That seems to be rather constant.

Observer B

(Jasmin 7 P) I could get something like a solidifying of the total experience, a thickening of the experience diffused through the body. (Mustard 15 P and U) The experience I have is modified a bit. It is almost like a congealing, a solidifying of my experience, total experience of the moment, and that solidifying takes place around the odor or sting. (Glue 15 U) A great lot of stuff accrued to that odor, pressure components, and the whole disposition was a mass-formation that seemed to surge and run a temporal course. It doesn't seem to have any specific quality itself. The significant thing seems to be unity, rather than the particularity of the modes and qualities. I haven't any name for that mass-formation. (Caryophilline 16 P) There is something big and expansive about the experience when I report P. It is an odor up until that rapid flux takes place, and then the odor is relatively unimportant though this filling flux is linked right up with it. The experience would not be judged P until the flux has taken place. (Caryophilline 17 P) The experience as a whole may take a new form. The odor is still a factor, but it is an odor with a great deal of accompaniment. The experience swells, and that swelling is attended by or is the P. When I say P it doesn't point to the experience as when I say cold. I'd say a sort of pseudo-pressure, maybe a pressure blend. P is more like wetness that way. Wetness is that integration of qualities, and P is a name for the integration derived from the odor stimulus. (Glass 18 P) There is a curious unification of all the experiences of the moment when it is P. I don't know if that unification gives a level pattern or not, I think it tends to be level; about as much vividness to the flux as to the sensory stuff. (Vanillin 18 P) The experience expands like dust or like smoke when a gun is fired. It is rapid and energetic as they are, not slow diffusion like cigar smoke through a room. The odor somehow seems to go out to the limits of the expansion too. I don't know that it does, but I get an impression it is beaten up through the whole thing. It was a flowery smell, but it isn't the flowery that spreads. (Vanillin 21 P) I don't think it's possible to

break the experience apart into an odor component, as such, and into a sort of pressure-expansiveness. That massive experience is a good deal like an orange in respect to red and yellow. One of them is an odor, in this case flowery, and the other is something related to pressure. (Glue 24 U) The odor had a very definite part in the accruing mass; I think it's fair to say like a flavoring in the pressure experience. (Vanillin 26 P) The thickening was like the change that takes place when a projection machine has been in focus and is then put out of focus. It is a surface with sharp outlines turning to a film without sharp outlines. So, here, the increment seemed to be more like a transformation of the given than like an addition of something new. If it were possible to tease out a pressure as one can ravel a string out into fibers, that kind of transformation is the kind of thing I had; and it seems to me that that transformation is P or P is the name of that transformation, which is a pressure. (Wool 27 U) The experience, as a whole, is duller. I can't find any single thing about it, though, that seems to be U and I don't think U is a descriptive term for it either, just a name it happens to have. Gives me the parallel again of wetness; wetness isn't descriptive of the pressure-cold that wetness has; quite so here, this flux, with whatever reference it has to the gritty, scraping pressure I have between my teeth, those two things taken together seem to be U. (Vanillin 29 P) There is a good degree of unification of odor and pressure-flux. The pressure seems almost odorous and the odor pressury. That was one of the experiences again where the whole thing seemed unified like a tonal fusion. It may be analyzable, but carries on the face of it a mark of unity, or its natural manifestation points toward unity rather than toward components that are easily analyzable.

Observer **F**

(Chocolate 7 P) The characterization, P, applies to the experienced complex, the predominant components of which were the quality of sweet and a brightness or lightness reminiscent of a bright pressure. The brightness or lightness character was not so much a part of the experience as an aspect of it. It covered the whole of the experience. All I can say is that the appearance of these characters touched off the report P, and with their disappearance there was nothing to which an affective report could be applied.

Observer **A**

(Cold steel 7?) Right at first, when I felt the cold, there seemed an affective tone to the whole experience that colored it. There was more there than the actual cold and this extra thing seemed to color the cold. (Caryophilline 7 P) There was this coloring all the way through. When I was left with just the smell it was clear and strong. The P came back, but then I couldn't say anything about it except that it made the experience be more experience. There was more at the beginning and end than there was in the middle; but still, in that middle thing, where there was nothing but the smell, the smell was clearer and stronger, and I could have said more about it than, if I'd been asked, I could at the beginning or end; there was more experience the other two times. (Egg 8 U) It seemed that this U belonged to the total experience; when I went to look for it I had to break up the experience. (Needle 8 U) The whole experience was U-toned; it went over the whole thing. It didn't make the prick more or less, but colored it all. Later it wasn't U at all. The quality was all there, but there wasn't so much experience, not nearly so much. The U was very much larger than the sensory quality. It was bigger, more voluminous. It swallowed the prick up. (Sweet orange 12 P) I talk about the attributes of the affection, but they aren't attributes of the affection so much as of the mass. It makes the mass more or less. What I'm saying is that when there is affection in the experience, the experience itself is a different kind

of an experience from the experience when there is no affection, and that although I can use the same terms to describe the two, nevertheless the two are different although it's still on an attributive level; these things go together, not as a product, but more like a product than a sum. It's not really a product, for there are still two things, not so beaten up that you can't tell them apart; and they don't make a simple, they make a complex; but it's a simple complex. (Mustard 18 U) With the going out of the experimental U the experience tightened up, it was more compact and, although it wasn't localized at all, it seemed to have its limits set more; that is, before the change came the total experience, or the part you could call the affection, was without reference to locality or limits; but the odor itself, after the affection went out, though it didn't become localized, seemed as if I could have localized it and I could have said more about how big it was if I had tried. I think these indefinite things are aspects of the affection, and I don't think that they belong to the odor when the affection is there; they are still aspects of the affection, but the odor is the thing you give me, and it's the thing that doesn't go, and so it's the thing that what I'm calling U not only clings to but which it, in a way, envelopes; not like core and context, but as if you had objects in a room and a deep fog settling over them,—and even if you knew they were objects, you can't get them away from the fog; you see them in the fog, but as part of the fog. So when I say these things about large, indefinite, etc., and think I'm talking about the affection, remember the odor is the more definite thing in the experience, the thing you can hang to, and I call the fog the affection.

Observer N

(Caryophilline 6 P) Mild, soft and warm experience, and this soft pressure was the P part of the experience. (Vanillin 6 P) Experience came as a total. (Bergamot 16 P) I'm so used to attending to it as a whole that it is hard to break them apart. I don't know the sensation from the affective part. (Loose fork 16 U) The U formed quickly, but all the time, with that, was the sound too. I don't think they were ever separated; they were together all the time. (Opal 16 U and P) Both the P and U were entirely wrapped up with the sensory experience. (Mustard 19 P) The experience first came as an odor, and then ran its normal course, and the affection came after and it seemed to expand quickly. During that course there was a great deal of movement where the affection and the sensory qualities were bound up or beaten up together, and it's only at the end that they separated and the affection seemed to well up and be enlarged quickly while the sensory seemed more of a flat nature. (Ammonium valerianate 19 U) It came as a total and then loosened up, and the components seemed to stand out and melt out into the affectiveness. The sensory was dominant the first moment, and that always seems to be the way. The affection never precedes the sensory and seldom comes with it. I can recall the sensory stuff and practically repeat the experience. I must recall the sensory, but then the affective is dominant. I can't recall the affection independently of the image. (Loose fork 20 U) Again the affection of this experience was swallowed up. It's drawn in, swallowed up, by the sensory. It comes in after the sensory and goes before the sensory. They are beaten up together, and the U is swallowed in a very determined way.

Observer M

(Mustard 18 U) At first the sensation is dominant, but an affective element is there. Then the affection is dominant, but the sensory part is always there. I don't connect the two, but they are always there. (String 18 P) The tickle was always there at a lower level, even when I was attending to the affection. (Hot steel 19 U and P) I can attend only to U or only to P, but the trouble is there is always sensation there, although I never

think of the sensation as being part of the experience. But when I attend to the affection to see if one affection, only, is there, why then there is sensation right there along with it. (Ammonium valerianate 19 U) It was tied to the sensation in the sense that the sensation has to be there in order for the affection to be there. I don't know whether to say they are beaten up or just lying there side by side; for you can get the affection so clearly and dominantly that you tend to forget the sensation,—though you don't ever. (Asafoetida 20 U) I can isolate it, but it's always there with the sensory. The sensation seems to be the track and the U runs on it.

Observer By

(String 15 U) It's sort of secondary, the sensation is primary. One thinks of the P or U as just coming of itself; but when you try to determine what it is, there is a lot to scrape off. (Vanillin 28 P) The odor experience came first, then the P, and they were attended to for the rest of the experience. The odor experience was there all right, all the way through, but never took the place of the affection as dominant. The two experiences ran along together but the pressure of the affection stood out more.

The Affective Qualities

All of our *O*s, early in their reports, make attempts to describe the qualities of P and U. From first to last the reports are made in terms of touch. The *O* may begin by saying the affective quality is like pressure but isn't one,—yet reports in pressure terms continue. All *O*s eventually describe P and U as 'sensory' pressures. They are "as much alike as if from the same matrix." There are many reports to the effect that there is no qualitative variation, and there is not one report that indicates any such variation.

P, in quality, is a bright pressure or a quality lying between bright pressure and tickle. It is described as bright; sparkling; brilliant; active; like effervescence; like tickle; dancing; shimmering; like points of light pressure; mild; misty; yielding; buoyant; vaporous; diffuse; light; airy; thin; fluffy; ethereal; smooth; soft; oily; welling; spreading; like the pressure component in warmth; like goose flesh, fur and glass; like muscle pressure in quality (not in density or localization), but brighter; like expansiveness of the body.

The quality of U is that of dull pressure or, according to some *O*s, of a pressure between dull pressure and neutral pressure or between dull pressure and strain. It is described as dull; drab; dead; rigid; less lively; somber; inert; stiff; gloomy; more dense; heavy; sinking; leaden; thick; cold; hard; rough; harsh; grating; insistent; condensed; like bodily contraction; like neutral pressure but duller; like dull strain.[3]

[3]It must be remembered that our *O*s were feeling for words; there is no reason at all to think that the various characterisations here listed refer to different modes of experience. Indeed, at the end of the experiment, all *O*s (except A and Br, to whom the question was not put) were ready to accept the designations 'bright pressure' and 'dull pressure.' It must be remembered, also, that all *O*s were familiar with the touch pyramid (E. B

Pleasantness: Observer H

(Chocolate 3) In this case there was a liveness, brightness to it. (Sweet orange 4) P is a bright, lively thing. (Bergamot 6) What I got was a general diffuse lot of brightness, a bit like bright pressure, but I don't want to identify it with that. It was this liveness, brightness, that made up the bulk. (Caryophilline 7) I think what I called the P-aspect of the experience or the aspect of the experience that made it P was that the thing was rather bright, lively. (Caryophilline 9) It is a sort of bright, lively, fluffy, ethereal-like experience. It is more like a pressure stuff than anything else. (Fish soap 10) When it shifted to P the whole mass of experience was brighter, livelier, more like a bright pressure than anything else. (Vanillin 11) There was a rapid alternation of the affective qualities, shifting from a light, airy, complex to something deader, duller, less volumic. (Fur 12) The affection was livelier, brighter, larger. Later a sort of tickle quality came in, bright, lively, but seemed more dense and in streaks. It was difficult to say what was affection and what was tickle. (String 17) A bright, dense experience. On the qualitative side there's a difference. It is hard to put it in words. It is rather bright in quality, and still a different kind of brightness; and the whole mass of the affective part is colored by this peculiar bright thing that makes the integrated mass different. It seems finer grained, it's softer. (Glass 19) I think affection is more like, in quality, some pressure quality than anything else. (Vanillin 27) In quality it's a little like bright pressure, but I can't identify it with any bright pressure I ever had; but it's more like that. It's like bright pressure with the pressure left out. (Sweet orange 28) The experience is very real, positive and just to say 'bright' doesn't mean much. It is almost as if there was a matrix a little like pressure. It is brightish, but there is more, it isn't just sheer brightness. (String 28) There is a sort of conflict between sensory quality and affective quality. The sensory quality is bright, more of the nature of the quality of P, it resembles P much more than it does U. (Glass 31) The quality is like an intermediate, somehow; seems to have a dual reference to something like pressure, though very different from the sensory pressure in that complex, and a slightly bright-like quality. (Sweet orange 32) The quality is pressure-like with a brighter component. (Chord 34) It was bright, I want to say dancing, but that has a connotation of too much violence; shimmering. (Jasmin 34) The affection is a pressury quality. (Fur 35) Not only did the two kinds of experience, sensory and affective, blend intimately, but they were very much alike. There is this difference, the affection is more uniform, in a sense smoother. The affection is bright but not ticklish.

Pleasantness: Observer B

(Asafoetida 2) A general, soft, diffuse pressure. (Ammonium valerianate 3) A very diffuse and weak sort of pressure. (Caryophilline 6) Something like the glow of warmth that I feel in the warm sun. It's deeper than warmth. It is soft like warm, and a good deal like pressure too. (Jasmin 7) It's like expansiveness of the body. (Jasmin 9) The P is like an expansiveness somehow. It is linked up with a bodily state of a pressure sort. (Jasmin 15) That bulky surge isn't particularized very much qualitatively. It's homogeneous somehow, but what it is that's homogeneous isn't apparent. It isn't odor, that's definite. (Caryophilline 16) The massive character is like body pressure. It is bodily, like pressure, and big and spread

Titchener, this JOURNAL, 31, 1920, 212 ff.), and would naturally look to it for descriptive terms. We cannot, therefore, regard their reports as evidence for the correctness of the Tickle- Bright Pressure-Strain and the Strain-Dull Pressure-Neutral Pressure lines of the figure; we can at most say that the lines, as arranged, served the purpose of the present investigation.

out like warmth, but more like the feel of pressure. (Pyridine 16) It was light like a light pressure, and I think I didn't have P except when that spread was present. (Caryophilline 17) This body reference is a good deal like pressure, very much the same character that the growing pressure of chilly goose-flesh has. The swell is much the same sort of thing in both cases. I'm not ready to say that the P swells; the experience swells and that swelling is attended by, or is, the P. (Vanillin 18) I'd still say pressure, but not any pressure I know. Might say a new form of pressure. It is soft like a warmth or like a touch of cotton wool. (Bergamot 21) There is quite a similarity between goose-flesh and the increment to the P, but there is some difference for goose-flesh is U. (Vanillin 21) I'm not sure if it is the odor that changes by becoming softer and more expanded or if some other experience that is big and soft is there. There is something that hints of an intermediate character, but it is pretty hard to pick the terminals; one of them is odor, in this case flowery, and the other is something related to pressure. (Fur 21) That soft pressure of the fur itself as cutaneous experience, and the slight warmth there is in it, is a lot like the pressure-like thing I've been getting. (Glass 24) I can get the lightest kind of a flux from that thing. It's very light, vaporous. It was P. It was light, lively, bright, and still pressure-like. It feels like pressure. (Caryophilline 26) There was an increment, sort of warmish, soft, pressure kind. (Glass 27) The same bright, easy, sort of flux. There is something lively about the experience. I don't know what that brightness is, I don't seem able to go behind it. Maybe the bright character of the experience could be called the P, and the dull experience I've had before, the U of it. The pressure-like experience, in both cases, is similar in its fundamental quality somehow. One is fluffy, bright, not sparkling quite but active like effervescence, and the other is gloomy, dull, dense like lead. (Asafoetida 28) This expansive, soft, pressure-like experience. (Caryophilline 30) Really overwhelmingly pressury, but the very loose, vapory, kind of pressure. I've tried to relate it to muscle. It's very like muscle pressure, but it's much softer and more diffuse. Taking it from that angle I hardly know why I thought them alike. Only in quality do they resemble each other. (Chord 31) Very soft, diffuse, vaporous kind of experience. It was the usual pressure all right. I'm not able yet to tell if there is any difference between it and the faintest kind of muscle pressure. Can't say what the difference is, unless the muscle pressures are better localized and solider. (Chocolate 32) Like the pressure component in warmth in lots of ways. Localization was the same, and pressure quality was the same.

Pleasantness: Observer F

(Chocolate 7) A brightness or lightness reminiscent of a bright pressure. (Sweet orange 25) Soft like a soft pressure. (Bergamot 30) There was something like points of light pressure, resembling the feeling of a small itchy surface, but lighter and with less body. (Caryophilline 30) Soft and pressury, as when you rest your finger on a heap of flour. (Bergamot 31) There was something that resembled light, lively pressure. The odor resemblance, itself, does not remind one of either P or U, but the texture or pressure component, on the other hand, seems to be identical with the affective feel. (Rose geranium 32) There was a soft, pressury feeling. (Fur 32) Smooth, soft, pressure. (Sweet orange 34) There was a pressure that was both soft and bright. The brightness of the pressure resembled that of tickle. (Rose geranium 34) The pressure was bright and lively like the tickle quality of pressure, and at the same time soft and smooth. (Sweet orange 36) The P of the experience was a soft pressure with a hint of tickle. (Bergamot 40) A very light, soft, pressure, just a little duller than tickle. (41) The difference between P and U observationally is a difference in pressure quality. P is always a soft, light, lively, pressure resembling most

the quality of tickle or bright pressure. The pressure is uniform. (Opal 42) It suggests softness, but there is hardly enough body to it to be called a pressure. (Chocolate 44) A soft, spreading, bright pressure. Then the P-pressure seemed to become lighter and more like tickle, though still a long way from it.

Pleasantness: Observer A

(Rose geranium 14) When the P was there the experience seemed lighter. The soft touches are more like the affections than the smells. This time the P was like lighter air and the U like heavier air. (Fur 16) The P seemed not to be much disconnected from the sensory stuff, it was very much like it. (Fur 17) The P was very weak, but quite a bit like the sensory stuff, more diffuse and not localized. The softness was like the affection. (Vanillin 18) There is something pressury and soft about the odor that is like P itself. (Sweet orange 18) P is always like a soft warmth. (Glass 30) The P was somewhat like this pressure, except that it wasn't so localized; it was smooth, but the smoothness is from not being rough, not from being in one definite plane as this, and it was much vaguer than this. I think P is smoother than U. (Sweet orange 31) The P seemed to be smooth. I think P is more like U than anything else I can find, and more like the smooth feels than anything else. (String 32) It is a soft pressury thing. (Vanillin 33) It was soft, like the odor but smoother and more oily. (Glass 34) The P is much like the tactual experience, softer, but smooth like the tactual experience. (Fur 35) The P was a lot like the touch this time, soft like the touch, smooth like the touch.

Pleasantness: Observer N

(Sweet orange 8) It seemed to be light, a pressure. There is a brilliance about it in its lightness. (Rose geranium 8) If I know what a bright pressure is, it was a bright pressure. It seemed alive, it grew out. (Rose geranium 10) It's a light pressure. (Jasmin 11) All the time it was active it was P, and all the time it was dead it was U. (Rose geranium 12) Luminous, active and light as if a light pressure. (Opal 13) It's a light pressure; brilliant, decidedly alive. (Chord 14) The P is light, mild, smooth, but a very thin experience. Still it is exceedingly active, active within itself. It's a bright, lively, slight pressure. (Chocolate 14) Not so much bright as light pressure. (14) P is a light, live, bright, thin, pressure. (Chord 15) Mild and soft, and while it lasted I felt live, soft pressure sort of envelope me. There is a brilliance about it, sparkliness. (Vanillin 15) A mild experience, quick, active, bright pressure.

Pleasantness: Observer M

(Fur 11) It was soft but not surfacy. The soft pressure tapered off. (Caryophilline 11) It seemed to be a regular succession of pressures, a band of pressures, in which all the little particles were in movement. I called it a pressure because that is all I could, it's the only way I know to describe it. There was nothing hard as if there were a definite surface, nothing but pressure, but not of anything, on anything. If you can image pure pressure, that was it. It almost seemed soft, yet nothing pressing anywhere to be soft. (Chord 12) It was very light, but still very compact. This is a pressury soft. (Vanillin 12) It was soft, almost a sharp softness. It is difficult to explain; as if it were a surface but yet, if you were to touch it, it would yield rather easily. It's soft as a whole, misty; but in parts of it, particularly in the nucleus, kernel, there is this bright, that is, keen quiet pressure-thing that makes it sharp. It's different from tickle; I'd say tickle was bright and this sharp, but it's only a difference in duration. (Vanillin 13) It came as a soft surface, just in pressure terms. (Jasmin 13) It was soft but continuous. It was light. If you could have a pressure out in the air that would be it, not localized and with no reference to me. Outside of that it would be a pressure. If there could be a pure pressure, that would

be it; that is, pressure, not of anything, on anything or from anything. The fur on the neck gives a pressure too, and that would be described in the same terms as an affective pressure; but you are connected with the pressure on your neck and not with this. (Chord 13) Very light pressure, airy, sort of buoyant instead of heavy and sinking. (Chocolate 14) Soft and vague pressure, misty or cloud-like. It was light, buoyant, as if it could float.

Pleasantness: Observer By

(Salt 22) It is a pressure. (Bergamot 23) A sort of pressure from the inside out, welling, loosely knit experience. It seems to be a pressure, I can't get anything else. They are touches, pressury in quality. (Chord 23) It's that welling, growing, pressure. (Bergamot 24) I feel pretty safe in characterizing it as a bright pressure. It is some kind of a pressure, but it's not tickle, not straight tickle. It's lively like tickle, but a soft pressure. It's liver than neutral pressure. (Fur 24) There came in this bright pressure, soft, loosely knit, filmy; big, bulky sort of thing. (Rose geranium 26) It's a touch quality, would fall somewhere around bright pressure. It's a pressure experience and a very lively experience. It's loosely knit, and gives an impression of soft.

Pleasantness: Observer Br

(Opal 1) The affection is mild. Something like a mild pressure. (Chord 1) It's a mild pressure inside. (Fur 2) It wasn't so much a pressure as tickle, very bright. (Chord 2) It's a bright feeling, very bright. Can't tell you just where it is bright, but all over. It's a bright pressure.

Unpleasantness: Observer H

(Mustard 2) The quality was the same throughout. It is a dull, heavy experience. I don't like heavy so much; dull, dead rather. (Glass 2) U is duller, deader than P. (Hot steel 3) More dense, duller, deader, though it is far from being dense. (Glue 4) Heavy or deadlike, not much alive; it doesn't mount up. (Sandpaper 6) It was a rather dull, pressury quality. (Sandpaper 9) The whole thing is duller, deader, less lively. The quality of that something resembles pressure. (Glue 27) Qualitatively it was much duller than the preceding experience [Vanillin P]. Fundamentally the two things [P and U] are as much alike as if from the same matrix. The former has a brightness touch, and this has a duller, heavier touch. (Crackling 29) A little like pressure, dull, but that's not adequate to the thing. (Vanillin 32) That pressure, something which I've never been able to identify with any particular pressure, slightly dull and heavy. (Wormwood 32) Something given experientially, like pressure, dull, qualitatively characterized by the dull heaviness. (String 34) A dull, drab, sort of thing, of pressure quality. I think the quality was uniform throughout.

Unpleasantness: Observer B

(Rose geranium 20) A big, massive pressure experience. These pressures come in the general setting of this big spread; that is, pressure-like, but not identifiable with any particular pressure I've experienced so far. I've been puzzled for a difference between the spread I call P and that I call U. In U there is a hardness or rigidity; I might say it is more tense. There is a hint of dullness or darkness about it. (Glue 25) This accruing mass of near-pressure seemed to be heavy and dull, rigid; insistent, somehow: sort of leaden, heavy, dead. I want to give the notion of somber character, inertness and hardness, not hard like ice, but hard and tough like lead. Just an impression of that kind of a pressure. I think it was harder, duller, heavier than those for P. They are bright, lively, vaporous, instead of leaden. (Glass 27) The pressure-like experience in both cases is similar in its fundamental quality. It's like two manifestations of a pressure; one is fluffy, bright, not sparkling quite, but active, like effervescence;

and the other is gloomy, dull, dense, like lead as compared with something like snow. (Wormwood 29) I get a tremendous surge of pressure-like experience that is definitely dull and somber and rather dense and heavy; dull seems to be the name for the experience as a whole, or at least for the pressure part of it as a whole. The same kind of difference holds between these U and P as between a dull pressure and a warmth. A warmth sits lightly, while dull pressure is a gripping, ponderous sort of experience; and I think that the P-flux and the U-flux have much the same difference. (Sandpaper 32) Stiff, dull-like pressure.

Unpleasantness: Observer F

(Sweet orange 28) When the hardness and concentrated aspect of the experience became focal it was U. (Ammonium valerianate 28) Something compact and hard, but not small. (Glue 29) The characteristic thing about it was a sort of growing, condensing pressure. (Asafoetida 30) Instead of the softness, something hard, like the feeling one has when a finger is pressed so as to affect the bone. (Glue 32) There was a pressury component in the experience which resembled most the strain I get with a slight wrenching of a finger. (Asafoetida 33) A sort of hard, granular pressure. (Asafoetida 34) There was a hard pressure resembling strain. (Asafoetida 36) There is a compact, hard, pressure, like the quality of strain, which is the U part of the experience. (Glue 39) The pressure here was thin and hard, surfacy. (41) U is always hard, dead, dull pressure, and resembles most the qualities of strain or dull pressure. (Glue 42) There was a dull, harsh pressure. (Needle 43) A condensation, a hardness. (Foetus 44) It was a thin, papery sort of pressure, very much like neutral pressure but duller, with no outline. (Vinegar 44) Pressure, heavier than the U in the previous experience. Nearer dull pressure than neutral pressure.

Unpleasantness: Observer A

(Rose geranium 14) The U is duller than the P. (Eraser 31) Something in the affective experience that was like the sensory experience. I think it had the characteristic of being rough, or of not being smooth; but when the sensory stuff itself is rough, it is hard to tell. (Glue 32) The U was a dull kind of pressury thing and it was vague too, like the P. Dull and cloudy are the only things that differentiate it. (Sandpaper 32) The U was dull pressure, a thickish, cloudy thing.

Unpleasantness: *Observer* N

(Glue 12) A heavy thickness, impenetrable and more definite form, and a decided pull to it, down, as if it were heavy; and all this means pressure. It was in being confined, harsh, that I knew it was U. (Bergamot 13) It was U, dead, still, thick and cold. U is a solid, heavy pressure, just pure quality. It was still and immovable. (Ammonium valerianate 13) Solid, impenetrable, thick and dark, like a weight, a heavy pressure,—that, altogether, is U. (String 13) I feel the heaviness about it, the decided, deep, dull pressure. (14) U is a heavy, dead, dull pressure. It is small, static, thick and solid.

Unpleasantness: Observer M

(Glass 10) The U-experiences are more compact, occupy less space, wherever that space may be; and they seem darker, blacker; and they are heavier than P is. There is a bright something about the P that U doesn't have. (Glue 11) It was a compact thing, closely pressed together, but not hard as a surface pressure. There was a vague cloudy something all around it. The cloudy part was soft and light pressure, yet not buoyant, for there didn't seem to be any life to it. A dull something like a mist. (Asafoetida 12) It was small, heavy and dull. (Flicker 13) It was a small thing and it seemed hard. There is a buoyancy about the P, a lightness in weight, as if it could float, that isn't in the U. The U wants to sink. (Glue 13) It was only this heavy, dull pressure-something. It seemed misty, out from the

kernel, but this core was very compact, heavy and dull. (Vinegar 14) Heavy and almost like a hard surface. Very small and dull. There is a deadness to it.

Unpleasantness: Observer By

(Salt 22) The experience is of a thin, rather compact, surfacy nature. It seems to be something like strain. Whenever I have to say anything about it qualitatively, I have to put it in the touch-group. (Mustard 23) I'd locate it on the touch pyramid somewhere; seems a sort of dull strain. It's shallow and hard, though the hard may be associative. (Flicker 23) That dull strain, compact, hard and surfacy. (Glue 24) Like a dull pressure but toward strain. This is shallow as compared with the other experience. (Asafoetida 25) A hard, thin, surfacy, experience like dull strain, nearer strain but like dull pressure.

Unpleasantness: Observer Br

(Vinegar 2) A sort of heavy, sinking, grating, feeling. It is compressed, heavy. (Glass 2) A heavy dull feeling, very grating. It's compressed. If there is such a thing as a heavy dull pressure, it is like that. (Sandpaper 2) A sort of a grating kind. I'd call it a very heavy dull pressure. (Mustard 2) I don't know whether you would call it dull or heavy. It was a pressure.

Affective Extensity

Most of our *O*s made their first affective reports on the aspect of extensity. Some described this as "the affective part" of the total experience, and many referred to affection, for some time, as "this volume-thing." The extent reported is bare extensity, not perceptive extent. The extents are never definite; that is, the *O*s report that they are always without boundaries.

P and U are both extended, voluminous; and all *O*s describe P as larger, more extended, more voluminous than U. One affection may be larger or smaller than another, and may itself expand or contract.

The *O*s are agreed that experience in these observations is always increased, extent-wise, upon the appearance of either P or U. They are agreed, also, that P alone is always larger than the accompanying sensory experience; but there is some disagreement whether U alone is larger or smaller. The primary sensory experience always becomes larger with the addition of P or U.

Almost every *O*, in speaking of P, has said that "it fills the whole field of experience." Speaking of U in this connection, they report that there is "no experience there" except the sensory and the U, but that this is "somehow smaller than P."

Many reports state that when P increases, volume also increases; and there is one report to the effect that, the smaller and denser the U-experience, the more U it is.

Observer H

(Salt 1 U) No definite extent. It has extent but not perceptual, no boundaries, but is volumic, not so different from sound. As far as I can say the volume of the thing didn't change. At first I thought it contracted a

little as it got denser, but I believe it was not any less volumic. (Fur 1 U and P) The U was very loose, volumic, without definite limits, rather small; and that seemed to be the affective part The P seemed a little greater in volume, still without limits at all, just a general impression of volume. (Mustard 2 U) It is one of those extents without beginning or end. (Glass 2 P and U) P seems a little more volumic than U for approximately the same intensity. The U seemed rather small in volume. The second P was more volumic than the first. (Hot steel 3 P and U) The P was a bit fluffier than the U, looser and more volumic. (Glue 4 U) The thing is volumic without any definite boundaries. (Eraser 4 U) The affection is an undefinedvolume. (Cold steel 5 P and U) With P the experience certainly seems more volumic, bigger, much less definite. With the shift to U the thing shrinks. (Bergamot 6 P) As if the smell were not the center of the mass but rather the liveness, brightness, that made up the bulk. Toward the end, the whole experience seemed to shrink a bit and was less lively and less P. (Cold steel 7 U) The affection is less defined in extent than the sensory stuff. (Glass 7 U) It is rather volumic. That is what seems to be the difference between the first and the last and the middle part. [Reported U, then neutral, then U again.] In the middle all that stuff was missing. (Chocolate 8 P) That space is certainly a very low order of perceptual space or just dimensional extent, not spread out as a surface; it is voluminous, big, fluffy, indefinite in boundary. (Caryophilline 9 P) The total experience is much greater in extent than the odor quality. The extent of the whole thing increased at the beginning and then ran quite uniformly to the end. (Mustard 9 U) It is largely extent or the volumic part of the experience that holds them [sensation and affection] together, is the cement. (Tansy 12 U) The affective part of the experience seems to be largely one of volume. (Glass 12 U) When the affective part came in there was an increase in the total volume, although the pressure didn't increase. (Fur 12 P) The affection, in extent, went beyond the pressure, it was larger. There was a sort of tickle quality that came in later and that seemed about the same general volume and extent as my affection. (Cold steel 13 U) Something more voluminous than the sensory stuff. (Vanillin 27 P) The P, as such, was very extended, filled the experience, was wholly indefinite in outline; it spreads indefinitely. (Glue 27 U) This experience is less extensive; I couldn't say where it ended, but it came as less extensive than the other [Vanillin 27 P]. (Rose geranium 27 P) The affective part increased in extent somewhat at first and with that was somewhat more dominant in consciousness. It certainly comes as more extensive than the preceding U experience; there is simply no stopping place. It fills the whole of experience. There is something about the experience that makes me say that this gives an impression of less thickness, tridimensionality, than the preceding U experience; not that there is any definite tridimensionality to either, but it is like tridimensional. There is more body to the U. (Sweet orange 28 P) The experience of P doesn't give quite so strong a suggestion of tridimensionality or thickness. It isn't a surface, but somehow comes as thinner. (Fur 28 P) The affection is formless. The P is more extended than the U, but equally formless. (Crackling 29 U) It's quite extended, more than the usual U, but not as much as some of the Ps. (Ammonium valerianate 31 U) The extent seems, in part, to be a function of attensity. When the affective part becomes completely dominant it seems to occupy the whole of experience. (String 34 U) The thing was not definitely extended, though, somehow, less than the whole field of experience. I don't know what the rest of the field is or just what I mean by the field of experience. I seem to have had experiences that were more extended, yet this seemed to fill all that was there. (Opal 34 P) That experience came in practically full-blown, and tended to shrink a little in going out. (Color strip 35 P and U) The U as against the P is less extended, but is as volumic as the P, and sometimes more positively thick.

Observer B

(Needle 4 U) I think of P as large, spacious. (Bergamot 12 P and U) The bigness and the looseness dropped out with the P. (Caryophilline 16 P) There is something big and expansive about the experience when I report P. It is a large odor, but the experience, aside from that, seemed to be big, bulky, dense. (Pyridine 16 P) It struck me that time more as a spread than a thickening, like a thin, vaporous something, rather than a heavy vaporous something. (Caryophilline 17 P) I don't think that the accompaniment is conspicuous quality any more than the odor is. It seems to be an increase in expansiveness, a great expanse, being something that includes a lot, not of qualities, but of conspicuousness. Like a high degree of attensity, like a thing that is vague except for a high degree of attention. (Vanillin 18 P) There was a stage where the experience expanded tremendously. It is the same thing I have called flux. The experience expands like dust or like smoke when fired from a gun. The swell is a change of magnitude and not of quality. (Guiacol 20 P and U) Whatever happened was something built around the somewhat resinous aspect of that odor, or added to it. I think the same kind of thickening or bulkiness I have talked about before. It is like all the experiences pointing toward something; and I think in this case it was a shrinking or a migration toward the center. (Rose geranium 20 U) There was a big, massive pressure experience. Massive is a good word in the sense of spread out indefinitely. It seems to be bigger than my body, and my body is in it. (Vanillin 21 P) The spread is indefinite. There is something expansive without limits. (Bergamot 23 P) That was a good instance of this spread. I got a great mass of experience, it spread all out. (Glue 24 U) Then the experience thickened up, spread out to take in more of a mass of quality of some sort. (Chord 31 P) P is very much like warmth; similar extent, but different qualities. (Chocolate 32 P) It was a big swell. When it came it was typical, but the size was particularly conspicuous. (Sandpaper 32 U) Restricted spread and just like other Us.

Observer F

(Rose geranium 42 P) The affective pressure was heavier than the pressure of the previous observation [Caryophilline P] and also more extended, but without contours. (Chord 42 P) No definite boundaries, but it appeared shaped in so far as it gave the impression of thinness. (Glue 42 U) No boundaries. The experience as a whole gave the impression of surfaciness. (Loose fork 42 U) The sound-experience was bigger in extent and less surfacy than the affective experience. (Fur 43 P) The softness and smoothness was bulky and contourless, and it seemed incongruous with the more or less definitely outlined, superficial, stimulated area. (Needle 43 U) The U was bigger than the sensory pressure-quality. (Chocolate 44 P) The P was bigger than the odor quality. (Vinegar 44 U) There was an U pressure, bigger and heavier than in the previous experience, not as large as but more concentrated than the P pressure. No definite outlines.

Observer A

(Hot steel 5 P and U) The P was greater than the U. (Needle 8 U) The U was very much larger than the sensory quality. It was bigger, more voluminous. (Mustard 9 U) The whole experience, when the U was there, was larger, not more intense or clearer, but larger, more of it. The U had gone before I drew away, and the experience seemed smaller then. This largeness isn't dimensional at all, just a lot of it there. (Vanillin 9 P) The P made the experience bigger and looser. (Citronella 11 P and U) The U was a large sort of a thing, and it was the most prominent thing in the complex, both on account of its intensity and its size. Its size belonged to the whole complex, it and the sensory part together. (Fur 12 P and U) The P made the experience larger in volume, but the U made it concentrate

in. The main effect of P and U is on volume and clearness, and usually makes the experience bigger. (Bergamot 13 P) The P was weaker and more diffuse than the odor. Diffuse is good, I like that word for that. It may have been bigger, but I don't know if the bigness belonged to the whole experience or just to the P. It is in this bigness that they [P and odor] come together. They're bound together so that some attributes can be attended to separately, distinctly for the sensation and distinctly for the affection. (Sandpaper 14 U) The U made the experience more. (String 14 U) The affection was more diffuse than any other part of the experience. (Sandpaper 15 U and P) This P, although it was not little in the sense of occupying little space, was very thin, but still might have had a lot of spread. It was certainly very much larger in bulk than the sensory stuff. (Fur 16 P) The P made it larger and looser, not so closely knit together. The P doesn't seem constricted, and so seems bigger. It is not like what you mean when you say boundless, but it has no hint of restriction or constriction. (Jasmin 21 P) This bigness, vagueness is a positive thing. The odor has more body than the P. (Ammonium valerianate 34 P and U) I think when it got P it got larger. (Wormwood 34 U and P) It got larger when it got P, and I think it got smoother. (Mustard 35 U) This seemed to be more dense and less extended than the Ps,and it seemed more irregular in its extent. (Needle 35 P and U) It seems that when the affection changed from P to U it tightened up, and got more dense and smaller.

Observer N

(Caryophilline 6 P) As the volume came it was P. (Caryophilline 7 P) It was a voluminous experience. (Rose geranium 8 P) The experience lifted, seemed alive; it grew out. (Glue 8 U) There was a thick firmness about the experience. It is a confined experience, whereas the P seems to be free. (Rose geranium 10 P) The first thing I got was volume. It was thick, but a soft thick. It grew in intensity and volume. While there was a lot of volume the experience seemed little, light in weight. (Caryophilline 12 U and P) The U has volume and is restrained, while P is indefinite, absolutely. (String 13 U) The U-experiences are more compact, definite and firm. (Opal 13 U and P) The P came and filled the whole experience. The P is much larger than the U, and there again the size seems to measure the intensity of the P or U. The P isn't confined in any way, it doesn't debar me. (14) P is large, voluminous and diffuse, U is small. (Caryophilline 14 P) It ran the usual course, swelled out, became larger, voluminous and thin. (Loose fork 14 U) More like a flat surface, hard, intense, and of small extent. (String 14 U) The volume seemed to shrink up to a point, small in extent. (Vanillin 15 P) Large volume. Just the same P, nothing different. Some are more intense than others—but that is about all the difference—or larger. I think the opposite is the case with U. The more intense, the smaller in extent.

Observer M

(Asafoetida 2 U) The U itself seemed shorter, more compact, as compared with the P of the former experiment; that is, there wasn't this general, wide-spread feeling. (String 2 P) The P was vague and widespread. (Vanillin 3 P) This sweet and slight pressure had a volume that included all of me in it. (Needle 3 U) It was different from the P in that my feel was limited. (Eraser 3 U) It was a restricted field of consciousness. (Hot steel 6 U) It was condensed, compact, not very big spread. (Asafoetida 7 U) It wasn't a very big experience. It seemed to have volume, but not a volume of anything. (Rose geranium 10 U) It was voluminous and extended back as if a bulk. It wasn't definitely bounded, and yet I wouldn't say indefinitely bounded either. It didn't seem to stop anywhere. I couldn't say here it is and here it is not, it was just foggy and everywhere; and yet it didn't seem very big. (Glass 10 P) P seems to be more vaguely

spread out. I mean, seems to cover a larger area, and to be particularly vague on the outskirts. The Us are more compact, occupy less space, wherever that space may be. The Us are more nearly definitely bounded and are smaller in area than the P. (Asafoetida 12 U) It was small, heavy, dull, and while not absolutely definite in its extent, still it seemed to be there more definitely than the other ones [P ones]. (Jasmin 13 P) There seemed to be a volume to it, and I don't know where I get the volume, for the only thing I get that I can talk about is the soft continuous pressure. It's vague and unlocalized and has no boundaries. Anyhow, there is this volume meaning attached to it. It feels as if there is a lot of stuff behind it, not a surface. It's a deep thing. (Glue 13 U) Not very big, although you couldn't tell any boundaries. (Chord 13 P) It was very vague and big and cloudy. It didn't have any contours, but there were some parts of it more compact than the others. (Vanillin 13 P) It was a big, vague, misty something. It was uniform all the way through, no clouding about it. It again comes as a soft surface, but has this volume attached to it, this deep something. (Chocolate 14 P) There wasn't much there, but it would cover a large extent. There is something odd about the extent, I could never say where it is nor how much, and there isn't any extent outside of the P; but it just seems bigger, especially bigger than U. (Sandpaper 14 U) It was little, very small.

Observer By

(Caryophilline 12 P) It had extent and volume. I could see the edges of it. The edges petered out, but I can't say anything about what it was set in. (Eraser 13 U) The U didn't stop with the sensory part of the experience; it's diffuse. (Vanillin 16 P) It was large, diffuse. (Ammonium valerianate 16 U) Diffuse and voluminous. This is diffuse, but not as voluminous as the P-experience. (Vanillin 17 U) Small in extent, compact. (Rose geranium 17 P) It was a big pressure, big in volume. (Asafoetida 17 U) It was compact and seems to be a surface quality, a flat, hard, experience. The flat and hard were the most noticeable things. (Bergamot 17 P and U) With the P came the welling pressure, with depth, almost tridimensional, bulky rather than surface. (String 18 U) The quality is surfacy, hard and very compact in places, almost form-like. (Wormwood 18 P) It was like warm, not the quality, but the way it wells out, diffuse, large, voluminous, loose, not as compact a thing, seemed to have depth, not the hard shallow quality the other [U] is. (Chord 20 P) Something that was volumic, diffuse, all-over, a swelling out, big and loosely knit. (Glue 20 U) A thin, compact, surfacy, strain-like experience, a diffuse experience, it doesn't grow, swell and expand, but comes in at a maximum all at once after the odor. (Chord 24 P) It's big, voluminous, seems to be all, it occupied everything, fills up experience entirely. It grows, yet you don't see it's bigger, it was big in the first place. (Glue 26 U) It's not big and bulky and voluminous, but it's not a sharp point either. It has a spread, a hard, thin, surfacy spread, not a point. It comes in full-grown and doesn't change after it comes.

Observer Br

(Opal 1 P) It has no shape, it's spread out and diffuse like warmth. (Color strip 1 U and P) U, to me, is sharper, more concentrated, not spread out like P. (Glue 1 U) Not mild and spread out like P, but concentrated. (Chord 1 P) All spread out all over. (Loose fork 1 U) It doesn't go so far. (Chord 2 P) Spread out, just as before. It takes in my whole being. Its spreadoutness is like volume in all the Ps. (Needle 2 U) Not as spread out as in the sound. (Loose fork 2 U) More spread out than some Us. (Chord 3 P) The affection is more spread out than the sensory experience.

Affective Intensity (Density)

We are not at all sure what variable or variables our *O*s reported under the name of intensity. For H, intensity of U is density, intensity of P is volume and brightness,—at least in some of his reports. The same thing is probably true for some of the other *O*s also; but there are many references to intensity that do not fit easily into such an interpretation. Such reports as 'moderately P,' 'intense,' 'fairly intense,' which occur all the way through the reports, are difficult to interpret, unless we are ready to take them at their face value. Usually, but not always, the characterizations 'intense' and 'rather intense' were given for U and 'not very intense' and 'moderately intense' were given for P.

In general, the P and U of our experiments are mild experiences, but may be relatively strong or weak.

The most direct reports are those of H, who says that at weak intensities P and U are very much alike, and that P remains affective quality at fairly high intensities, whereas U becomes perceptive, goes over into emotion. B also remarks that at higher degrees of intensity U is like anger.

The patterns for intensity found by the various *O*s do not agree in detail. For H, who reported upon patterns at much greater length than any of the other *O*s, they are, however, definite and constant to a high degree. In U-experiences he finds a greater density at a central core, although he denies that the experience has any definite form; out from the core the density decreases. P-experiences have no such core. The characteristic, prominent or dominant part of the P-experiences lies toward the periphery; though here again H denies any sort of perceptualized form, or any definite extent of any sort.

Observer H

(Wool 1 U) The U itself was weak in intensity. The intensity was not uniform, however; it fluctuated with the direction of attention. If I attended exclusively to the quality of the touch experience, the U became very weak but not zero. I got the most intense affective experience when attention was directed in part to the experience as object or to the stimulus. (Salt 1 U) It simply became more intense, and by that I think I mean more dense. It really seems that the affection, as affection, was more dense, more compact. It contracted a little as it got denser, but I believe it was not any less volumic. (Mustard 2 U) The U tended to increase in intensity up to the time of withdrawal, and by that I think I mean it became more dense as experience. (Sweet orange 28 P) The affection increased in extent and density, at least there was more of it there. There is a more or less that doesn't seem to be simply intensity. The textural aspect is loose, felty; whatever slight variation of density it shows is slightly stringy and lying roughly in the direction that radii would take; only in the U the thing is more haphazard, like felt, a mass. (Fur 28 P) The very central part of the pattern for P is somehow different; it is the same quality as the whole pattern, but lacks these shifts in density, so it doesn't seem so lively. (Crackling 29 U) It wasn't so very dense, and not quite uniform in density;

but the distribution of density is in little larger patches than for the P, though that variation in density isn't great; no sharp edges of density. The density grades, there are no sharp boundaries, it is more like rolling hills than steep precipices. It seems to be characteristic that it's a bit denser at the center, more of the stuff, a sort of pseudo-density, but the actual stuff itself isn't denser. It is rather the central part of the pattern that seems to dominate. The boundary is indefinite, but it does tail off more or less from the center, though fading out is more rapid at the periphery, which isn't true of P. It increases away from the center and then tails off. (Bergamot 29 P) It is not very dense, but with characteristic slight shadings of density, in which the differences of density were small and tended again to be a stripe-like pattern as against the U which is the hill-effect, hill and hollow, mass-effect. At times the center of the P-pattern is practically blotted out by the sensory component which seems denser at the center. This isn't always true. I get more of that variation of density out from the center a bit. (Caryophilline 30 P) The brightness of this was quite weak, slight. The experience showed very little of the usual density gradations or differences. It was almost uniform, density-wise, not very dense, very little of what I call liveliness. (Glass 31 P) It seemed to get more extended as it got more intense and probably thicker. There is a characteristic there I don't like to call dense, more of it. It thickened up. The sensation, over against this is more dense, more bulky. (Rose geranium 31 P) The P was more intense than in the last experience. Intensity seems to be two things, greater amount and greater brightness, as if it swung along a series toward the brighter extreme. There was very little of the diffuse pressure stuff there. The brightness of quality seems to go along with a change in density. More dense and more streaked, thread-like bits, though the shift in density is gradual, not sharp, and diffused all over the pattern, especially the peripheral part of the pattern. P will remain just simple P at a fair degree of intensity, while U at a certain degree of intensity shifts over to an emotion. Object-consciousness is more apt to come in. I shouldn't say necessarily, but just seems to do it often. (Ammonium valerianate 31 U) At the very beginning very weak, and then P and U are much alike. The difference is more pronounced as they become more intense. There is always an element of likeness, though, even so. (Jasmin 34 P) The intensity weakens toward the margin, and I think the quality is a little brighter. It seems thinner toward the margin, maybe 'less dense' is better than 'thinner.' 'Thinner' seems to imply that it is perceptualized as a found mass, which it certainly is not.

Observer B

(Vanillin 18 P) The swell is largely intensive; at least it's a change of magnitude and not of quality. (Chord 30 P) The P is a little more firm, more developed somehow, more of it, or more intense perhaps. But the increase in intensity is more like a chroma change than ordinary intensity; it seems to thicken up, it was richer more than just more. It may be intensity. (Loose fork 30 U) It was really a pretty intense experience as these things go. It was very U. It was a bit like anger, though I don't know just how.

Observer F

(41) Intensively the affective pressure is uniform, both P and U. (Loose fork 42 U) There was a difference in intensity or insistency.

Observer A

(Tickle 15 U) It is hard to compare the intensities, but easy to compare the extents. (Sandpaper 15 U and P) This P was larger than the sensory stuff, but not as intense. (String 16 U) I've tried to talk about intensity, but intensity isn't right. What it means is not that the thing is very U

or not very U; but the reason I say 'strong' is that in spite of all these things I seem to be more aware of the U than the sensory stuff. (Mustard 33 U) The thickness of P is like oil, transparent, but the thickness of the U need not be heavy, but cloudy.

Observer N

(Mustard 7 U) It was very intense, very U, but it didn't seem to grow. (Rose geranium 8 P) The intensity gradually faded out. The experience lifted. (Glue 8 U) It was intense, seemed an even experience in intensity throughout. (Jasmin 10 P) It was thick, fairly intense. (Asafoetida 10 U) It was intense, thick. (Rose geranium 10 P) It grew in intensity and volume. (Opal 13 P) Not very intensive, the P, though very large. (14) U is usually more intense than P. (Vanillin 15 P) Just the same P, nothing different. Some are more intense than others—but that is about all the difference—or larger. I think the opposite is the case with U. The more intense, the smaller in extent.

Observer M

(Mustard 4 U) The U was a pressure, thin and fine like a pin; that is, it seemed to be most intense at a point, and from there to 'peter out.' (String 5 ?) It was small but intense. (Caryophilline 5 P) It seemed dense in the center and 'petered out.' It was vague, with a more intense concentration, and then tapering off. (Bergamot 6 P) It was a P with a hard kernel, but clouded off. (Chord 12 P) It had a more dense or concentrated core, and the other softness came out less intensely. (Vanillin 13 P) It was uniform all the way through, no clouding about it. (Sandpaper 14 U) It had a hard core, and this core was surrounded with a mist or something soft.

Observer By

(String 16 U) The experience was more intense, more U than any of the others. (Vanillin 20 P) It grows, not in intensity, unless the intensity of a volume. (Glue 24 U) Seems somehow more intense than the P-experiences. I can't think of P as intensive; it gets bigger, but this seems to have intensity, sometimes greater and sometimes less.

Observer Br

(Caryophilline 1 P) It had more intensity or brightness.

Affective Time-Relations

P and U are always coincidental with sensory or imaginal experience. The affective increment usually follows the primary experience, and never outlasts it.

The experience runs a course which may be intermittently affective and non-affective.

Observer H

(Glass 2 P and U) There is, at the very beginning, and this seems to be general, no affection for a moment. It is not there instantaneously. It was then slightly P, and then weak U, and shifted again to P. (Needle 3 P and U) At first slightly P, then slightly U, but with a gap where there was not an affective experience. The U rose to its maximum very quickly. (Cold steel 5 P and U) There was no affection at the very first, then a short interval of deep P followed immediately by U. There was no neutral interval. (Caryophilline 21 P) Quite gradually, but rather rapidly, the affection came on top. The change from dominant sensory to dominant affective is not step-wise nor instantaneous, but gradual though quick.

Observer B

(Pyridine 16 P) So far I have odor and then the affection after a perceptible interval. (Caryophilline 17 P) The flux and the odor are coinci-

dent in time anyway, if not in space. (Vanillin 18 P) The striking thing is that it grows and wanes rapidly. It has a definite course in time as much as a movement has. It disappears like a dissolving view. (Guiacol 20 P and U) This affective spread certainly is a temporal growth, it has a temporal course too. (Wormwood 29 U) The P-flux is active like goose-flesh running a course. It's true that the U-flux grows too, but it doesn't grow in the same way. It drags in or grinds its way in.

Observer A

(Tickle 13 U) The U lagged a little behind the change in sensory stuff. (Bergamot 13 P) The P didn't come immediately; at first I just got the odor.

Observer N

(Sweet orange 17 P) The very first is purely sensory, then strongly affective. (Loose fork 17 U) The affective and sensory came together there. The affection died out with the sensory. (Glue 20 P and U) At first sensory, then P, then U; and the U was gone before the sensory hang-over was gone.

Observer M

(Glue 20 U) The experience comes first as olfactory and then as U. When the odor is gone, the U is gone. (Ammonium valerianate 20 U) The olfactory experience always comes first; and while you may let the olfactory part drop to a lower level, still it is always there.

Observer By

(String 18 U) Shortly after tickle had been in consciousness there came the dull strain. (23) Both P and U come in after the sensory experience and go out with it.

Observer Br

(Colored strip 3 P) I have an image of it. The affection lasts with the image and goes out with it. (Loose fork 3 U) It came with the sensation and didn't last any longer. (Chord 3 P) The hanging-over lasts as long as the affective experience.

Organic Sensations

Our *O*s found organic sensations practically whenever they looked for them; but they failed to find any such sensations that were constitutive of an affection, or covariable with it, if affection was reported.

Many of the following observations were made under the instruction for organic sensations given above. Some of them were made in the general report of experience.

Observer H

(Caryophilline 7 P and U) There was one brief moment when I know there was some organic stuff there, which may have been present the rest of the time; but this organic stuff was someway detached from the odor. (Rose geranium 22 P) Practically the whole of attention was directed toward pressures in the body, mostly respiration. There was very little there even as odor. Then I turned attention to the odor and it came weakly P, but pretty much a meaningful P. No attempt was made to attend to P. I watched for organic change which I already had a sort of standard for. I can't say I found anything more or additional when the P came in, though I wouldn't be very dogmatic about it. (String 22 P) There was practically no affection at first, I was set for the object as an affective object. At the very first there was just contact. Then it turned over to a P-experience, again in a meaningful sense. There was no organic

reaction at all that I could put my finger on, though I gave myself up to it as far as I know how; but the whole meaning of P, the whole participation of P, seemed locked up with the cutaneous experience on my lips; it seemed to be the whole vehicle of the affective experience. I didn't get a thing. (Needle 25 U) At first just pressure, sensory stuff, localized at a point on the arm, then very quickly it became slightly U. Then I took it as a pricking object, and immediately there was a weak kinaesthesis in the arm that meant withdrawal, but did not relate particularly to the affection. It related to the disagreeable object, but in no intimate way to the affective aspect of it. I noticed also a slight shift in breathing but not any particular sensory thing connected with it, nothing I could put my finger on, though I know there was a change in the general bodily tone or feel in the thorax. That was simultaneous with the shift in attitude. Just slightly later I found some dull pressure, almost draggy, localized in the upper abdominal region that was fairly limited in extent though not definitely bounded; the whole thing was heavy, rather persistent; it also meant something like thwarted escape or withdrawal.

Observer B

(String 19) That hangs on, had to rub my lips. I dislike that thing, but I don't know if it's U. There was a lot of motor reaction, all avoiding. I get that from the tickle. There was a very definite meaning of 'getting away from it.' That was positive in it, but I don't know if there is something added on that I can call U. Here's something I don't like, something disagreeable, but I don't find anything I can call an affective state. (String 22) That's a powerful something. I can't decide whether it was U even. There was a lot of involved muscular reactions. I think if I could get away from that it might become U maybe. I can't find any U as such though. Just a motor reaction. The whole emphasis is on getting away instead of what it feels like. (Wormwood 29 U) It always has or generally has the context of facial pressure, as I feel when I turn up my nose at something. I wouldn't call that the P or U either; it seems to be coexistent with it but not related in any sense.

Observer A

(Mustard 22 U) It was U, but I didn't find any organic sensation, except that between my nose and throat I feel a contraction. It's like a swallow, but too high. I got the affection right away, but not the contraction till the odor became strong. This contraction was getting stronger, and the U had practically disappeared. (Fur 22 P) At first I drew away from it. That was before the P came. Then as the P came I relaxed, so far as I can tell. Drawing away was a stiffness in the shoulder. I might say the P was connected with the relaxation; but that was negative, just a letting up of the strain, and the P was strongest after that was over. (Jasmin 23 P) My throat closed. There was a tendency to swallow and some pressure down in my throat. There is no connection between the P and closing of the throat. (Chocolate 24 P) I didn't have anything organic, and the P was palpable. (Jasmin 26 P) A lot of these odors give me a pressure in my throat, the P and U alike. I don't think it means anything; but if I had to put a meaning on, I'd say U. But U didn't really come in, either as meaning or otherwise.

Observer M

(Glue 21 U) There were no organic sensations that occurred concomitantly with the sensation. There are usually organic sensations if you look for them, but there were no changes in these when the U came in. (Asafoetida 21 U) The only organic sensations were those that were there before the U came in. No change in organic sensations, and no organics related to the U. (Bergamot 21 P) There were no organic sensations connected with the P.

The Affective Qualities as Palpable

The affective qualities are palpable, that is, they stand up under observation. All of our *O*s were able to observe both P and U, but none could attend to either to the total exclusion of the sensory experience. The affective quality may be the dominant part of the total experience, however, and the *O* may know more about it for report than he does about the sensory process.

Observer H

(Wool 1 U) The attempt to direct attention exclusively to the U was not successful. The intensity was not uniform and fluctuated with the direction of attention. If I attended exclusively to the quality of the touch experience, very little U was there, or if I disregarded the pressure experience the U became very weak but not zero. I got the most intense affective experience when attention was directed in part to the experience as object or to the stimulus, and in part to the affective aspect. (Pyridine 1 U) It was an object of smell quite U. Then I attended to the smell for the sake of the smell, and the U diminished. Then I shifted back more to the attitude of the first instant, just taking it as something there; the U increased. At no time did the U reach zero intensity. Attention to the object of stimulation in its U-character seems to be most favorable for affective experience. I don't know if that means I'm attending to the affection, but it surely is the object as an U-object,—not just U and not just object, but attention covers the affective nature of the object. (Salt 1 U) I couldn't attend exclusively to the affection, and don't know if I did primarily; but U forced itself to the fore in attention, a sort of an oscillation. Toward the end the affective part was fairly attended to. (Fur 1U and P)Attention shifted to the sensory aspect, and affection dropped out. Then it came as P. The U at first was pretty much focal, but was an U s*omething.* (Mustard 2 U) These [sensory] qualities are not very clear for attention; it is rather the object of experience that I can't get away from, and the U object is what holds attention; so I can't say U dominates; it is just one factor in the dominating complex. So far as quality in the experience is concerned I think the U was the most vivid, most clear. (Glass 2 P) I was unable to hold the affection, as such, exclusively in attention, but it seemed to stand in the dominant complex for attention. (Ammonium valerianate 3 U) I endeavored to get the U focal for attention. It remained U odor throughout. The U of the odor seemed to be as focal as the odor, but the U aside from the odor, in and for itself, was not dominant. (Hot steel 3 P and U) The P seemed to be more or less focal along with sensory experience, but I can't get my attention to take hold of that thing for itself. (Eraser 4 U) I think I can observe the U all right. It is not, of and by itself, focal for attention, but it is more or less for report; that is, it is as if the report attitude was, to a certain degree, independent of attention or clearness or vividness. It is as if I can take an attitude for observation and consequently for report that includes only a part of the total focal complex, and by focal I mean focal for attention. (Salt 5 U) Then came the U under the observational attitude, but attention or the vivid or clear experience was the total complex, though I was set to report on the affective aspect. It really seemed, there, that I could catch the U coming in, observe the change in experience. (Cold steel 5 P and U) It is as if I could attend to the affection if I take it along with the other. (Glass 5 U) I didn't succeed in isolating the affective experience in attention, but I attended to the total complex of which it was a part; and so far as I can say the sensory part doesn't dominate the affective part, it is all on a level. (Glass 7 U) The affection was pretty directly under observation, but not isolated in attensity.

Attensively it was as high as the sensory, it was all on a level for attention, but for observation the affective stuff was clearer. I know more about it for report than I do about the sensory stuff. (Caryophilline 9 P) I think that I had the best and most uniform direction of attention for affection that I've had so far. The quality of the odor was not at any time attended to directly but the odor was always there, somehow beaten up with the affective stuff. (Rose geranium 14 P) At no time did the smell become dominant, at no time the principal element in the experience. The affection stood out, dominated, seemed the principal item of experience, and the smell somehow belonged to the affection. (Glue 15 U) The smell as specific didn't come out clearly at any time. The experience was U, and in a general way I knew about the nature of the smell quality, but more after the experience was over than during it. (Fur 15 P) The affective side of the thing was dominant though the sensory stuff was there. There was almost an extensive separation,—not fully; the cutaneous stuff stood off clear to the side of the affective stuff, still not isolated from it.

Observer B

(Jasmin 15 P) I'm not sure that I noticed the odor that time. (Bergamot 16 P) I don't know what I mean when I say slightly P. I don't know if it means there are degrees of P and U or degrees of conspicuousness of P and U. (Caryophilline 16 P) I think the experience is odor till that rapid flux takes place, and then the odor is relatively unimportant, though this filling flux is linked right up with the odor. (Vanillin 19 P?) The spread varies in extent and something like the vividness of it. I guess that's where the more or less comes from. (Vanillin 21 P) Fairly quickly this massive formation of the experience occurred. It is largely odorous. I don't think it possible to break the experience apart into an odor component, as such, and into a sort of pressure expansiveness. (Rose geranium 23 U) The experience will solidify and thicken up. The thickening is definitely odorous, but so much more than odor. The odor is like a flavoring in it. (Bergamot 23 P) It seems to be dependent on the odor, seems to have an olfactory component, not a component that is observably separate from the great mass of experience. (Glue 24 U) I couldn't center on it too much or it changed. As soon as I set myself to observe it, I found myself facing the odor; but so long as I took a casual, relaxed attitude, then the experience thickened up, spread out to take in more of a mass of quality of some sort. The odor had a very definite part in the accruing mass. I think it's fair to say like a flavoring in the pressure experience.

Observer F

(Sweet orange 28 P and U) When the hardness and concentrated aspect of the experience became focal, it was U. (Rose geranium 28 P) There are those differences of lightness, softness, and brightness as against sharpness and hardness, compactness, etc. and they seem to hang on to the experience, to be a closely integrated part of it, and they seem to be sensory, palpable. (Vanillin 29 P) The softness was more focal than the floweriness.

Observer A

(Chocolate 8 P and U) The P was the prominent thing in the experience at first, and it seemed larger than the sensory qualities, but very closely bound up with them. I was attending to the total thing. The last thing that was affective was U, and at that time the clearest thing was the bitter. The U seemed to come along with the bitter. (Mustard 9 U) The U persisted for quite a while even while I was attending, but I can't say much. There was more there when the experience was U, but the U was closely bound up with the odor itself. I tried to get more, the U had gone away. Then the odor was more clean cut, clearer, more pronounced, clearer as vivid and also as standing out in consciousness as over against anything

else. (Vanillin 9 P) The P was different from the odor but very close to it; they belonged together in the total experience. The quality of the odor was much more distinct when the P wasn't there, still it was the quality of the thing that the odor was bound up together with. When the quality of the odor became clear the P was gone and the odor was more definitely an odor. (Citronella 11 P and U) The U was a large sort of a thing, and though not what you could call clear, it overshadowed the whole experience. I'm not willing to call it clear because it wasn't distinct, but so nearly as I could tell as distinct as any other part and it was the most prominent thing in the complex, on account of its intensity and its size. (Rose geranium 11 U) I wouldn't say the U was clear, it really wasn't; but the U, taking the whole experience, was the big, dominant thing. (22) I can observe the sensory stuff alone or the experience as a whole with the P or U, but never the P or U alone without the sensory stuff. (String 23 P) There was palpable P. (Glue 24 U) This was palpable U.

Observer N

(Ammonium valerianate 19 U) It came as a total, and then loosened up and the components seemed to stand out. The sensory was dominant the first moment, and that always seems to be the way. The affection never precedes the sensory and seldom comes with it; but it may remain after the sensory has gone, for I can recall the sensory stuff and practically repeat the experience. I must recall the sensory, but the affection is dominant. I can't recall the affection independently of the image. (Glue 20 U) That was a complex experience and at first sensory, then it became P, and the affection was practically all. It was independent of the sensory except that it seemed attached in some remote way. Neither P nor U is wholly independent of the sensation. (Loose fork 20 U) It comes in after the sensory and goes before the sensory; but the sensory hang-over brings another U. I can recall it, but the sensory hang-over is there. I can't look at the affection and then go back to the sensory and find it gone. (Wormwood 20 P) I came much closer to having the affection independent; but there is something that ties them together. It may be a hang-over from the sensory. The P wells up and seems above and bigger and decidedly the dominant feature, yet there is a union. I tried to see which left first; I just find both gone all of a sudden.

Observer M

(Hot steel 6 U) It seemed to be hiding behind the sensation; it was there, but it took time to find it. (Glue 19 U) The sensation was always there. I wouldn't say that the U was a smell-U. I wouldn't link it up that way; the U hasn't any smell in it; but I'm always smelling, even though I'm looking at the U. (Asafoetida 19 U) No matter how much you attend to the U there is still that sensation there with it. They are coexistent rather than dependent. (Ammonium valerianate 19 U) I don't know whether to say they are beaten up or just lying there side by side; for I can get the affection so clear and dominant that I tend to forget the sensation, though I don't ever really. (Asafoetida 20 U) I can isolate the U, but it's always there with the sensory.

Localization

Many of the *O*s, in their earlier reports, attempt to localize the affection, and often mention a more or less definite region where it is felt. Later, however, they speak of a 'reference' to a part of the body and deny the localization. All the *O*s finally report affection to be unlocalizable, but they may still refer it to their whole body, and the affection may include the body or be projected out from it.

There is a tendency, at first, to localize affection in the region of the stimulus; but H remarks: "I think it was nothing but localization of stimulus." H further reports that when the affection is dominant there is no localization, but when the sensory part of the experience is dominant, there is always or often localization.

Observer H

(Wool 1 U) There was a tendency to localize the affection in the region of the stimulus, but I think it was nothing but localization of stimulus. (Chocolate 3 P) When I have the attitude of just disinterestedly, or more or less casually, but attentively, letting the experience go on, the whole matter of localization becomes indefinite. (Eraser 4 U) I don't know where it is in regard to localization, except that it belongs together with the sensory complex. (Bergamot 6 P) Not localized. (Cold steel 6 P and U) Localized in the arm; or referred to arm and body, rather than localized there. (Cold steel 7 U) It isn't localized so much in the body as with the sensory stuff. It is hard to get at. (Fish soap 10 P and U) U lacks localization. (Juniper 11 P) The experience was not definitely localized. Hardly any reference to localization, except just 'out there' somewhere. (Tansy 11 U and P) It was as if I were standing off over against the thing almost, looking at it as an outsider. (Bergamot 17 P) Then the active attitude dropped out, and the affection became dominant; the localization dropped out. (Mustard 17 U) Then the affection became dominant and there was a loss of localization. It was everywhere. It reached the total possibility of extent, as if I were immersed in it. I don't mean any reference to my body; there was just nothing in experience but that. (Glue 18 U) I never was rid of the olfactory part of the experience; but toward the end it came to belong to the affection, rather than the affection belonging to it; and it lost all sense of localization, just experience, extended, practically filled experience. (Bergamot 20 P) When the affection becomes dominant there is a lack of localization, even though the sensory aspect is there. It becomes given experience. When the sensory aspect is dominant there is always localization. (Jasmin 21 P) The affection is never the object of localization. (Fur 28 P) When the affection is dominant the whole complex is unlocalized. When the sensory part is dominant, it is often localized. If the P and U are weaker, they cling to the sensation. (Flicker 35 U) I don't know where the U was, out there or where; it just was.

Observer B

(Pyridine 6 U) The U isn't localized. (Jasmin 7 P) Diffuse through the body. (Glue 15 U) It has a positive bodily reference. The odor doesn't seem to be a part of my bodily constitution, but this massing is. (Glass 16 P) What little addition there was wasn't localized as the smoothness. The smoothness was localized in my fingers; this other part seemed more nearly bodily than bound up with the fingers or glass, though not exactly, not specifically anywhere in my body. (Caryophilline 16 P) It seems distributed throughout the body. It isn't localized, but it is bodily somehow, and just the opposite of film-color, which is definite enough with respect to a kind of orientation but is definitely not localized in any one place. The odor isn't anywhere and the flux is there with it. (Rose geranium 20 U) I've sometimes said that affection is localized in my body, but I'm not sure that it isn't projected. It seems to be bigger than my body and the body is in it. I seem to take it as including me, rather than as detached from me. (Vanillin 21 P) There is a general spread that includes a good deal more than the nostril, and I'm not sure that that spread is at all in the nostril. I think I may have only referred it to the nostril. It is of very vague localization. (Mustard 25 P) Vague, localization very uncertain. It belongs

to me, somehow, in my body or in contact with my body, nearer my face but not in any one place. (Wormwood 29 U) Vaguely localized. That flux was widely distributed throughout my body, it was all through my body. (Opal 30 P) In so far as the P was localized at all it was around my face. It is as hard to localize as radiant warmth. Warmth seems to come up against the skin, and the P seems to come like a cloud or vapor around me and otherwise isn't localized at all. (Colored strip 30 P) It takes its orientation about my face very much. It isn't localized there, directly, not in the face muscles. It's like warm.

Observer F

(Rose geranium 42 P) Localized in the smell experience. (Chord 42 P) Just localized in the tone. (Glue 42 U) Unlocalized. (Foetus 44 U) Unlocalizable, surely not localized in the stimulus. (Vinegar 44 U) Indefinitely localized.

Observer A

(Hot steel 5 P and U) I can't say where from or where localized; the P didn't belong just to my arm but to my whole body. When it got U the thing belonged more to my arm, not localized in my arm, but belonged there. (Chocolate 6 P) The pressure was not localized anywhere. (Vanillin 9 P) The P itself isn't definitely placed, not in reference to my body or to anything, so it kept the odor from being definitely localized. (Sandpaper 15 U) It's easier to get it out in the tactual experiences, because the sensory stuff is localized and the affection isn't. In the odors neither is localized. (String 16 U) The U is unlocalizable, doesn't belong anywhere, inside or outside. (Caryophilline 17 P) There seemed to be an indefiniteness of localization of the whole experience. When the P was there, there was a vagueness which made a difference in localization. (Sweet orange 17 P) The experience didn't get localized very well, but better without the P. P and U are both unlocalizable. (Glass 20 P) It seems that the localization is something I get immediately from the touch, and it is important to the touch, as touch, but not to the experience as a whole. (Fur 21 P) The touch was localized, the P wasn't. (Fur 26 P) The P wasn't localized, not with the pressure nor away from it either.

Observer N

(Sweet orange 8 P) I couldn't localize it anywhere, it seemed to be all over me. (Jasmin 11 P and U) While P it was part of me, and when U I didn't have anything to do with it. When P it is more like a pressure, but I can't say in *me*. It's decidedly out of me. (Caryophilline 12 P and U) That completely filled me. I feel it but I don't know where. (Bergamot 13 U) It was in me, I don't know where. (String 13 U) It seems I should be able to say where this is localized, but I can't. (Opal 13 P) It isn't in me, it's out of me; but it's around me, somehow. (Caryophilline 14 P) The pressure is outside of me, enveloping me.

Observer M

(Vanillin 4 P) It was very diffuse as if spread over a much larger area than it possibly could have been. (String 5 P) It wasn't localized, except that it seemed to be in front of me where I could look at it. (Bergamot 6 P) The P is all around, but I don't know where, and I can't say where it ends. (Vanillin 6 P) I don't understand about where it is and I can't tell where it is. (Chocolate 8 P) I don't know where it was spread around; it occupied a lot of space but I don't know what space. (Asafoetida 9 U) These things are odd; they seem so definitely there that I feel I should be able to touch them; but the trouble is you're not connected with them, you are not *there* in the sense that they are. (Fur 10 P) It isn't cut off from anything else, it is just there. (Caryophilline 11 P) It almost seemed soft, yet nothing pressing anywhere to be soft. If I could only localize these

things or place them where I could talk about them,—but they are such vague things I can't talk about them as I can about sensations. (Glue 11 U) I think the thing that bothers me is the way I seem to be disassociated from the experience; that is, it seems just as real as a sensory quality, just as existential and just as independent of me, but as a conscious organism I'm not even there. (Jasmin 13 P) It's as senseless to talk about pressures you don't feel anywhere as about a color volume you don't see. If you could have a pressure out in the air, that would be it, not localized and with no reference to me.

Observer By

(Asafoetida 10 U) Not localized anywhere. (Glue 12 U) Unlocalized. The odor was localized. (String 13 U) Not localized. (String 19 U) It seems equally distributed over the body. (Jasmin 19 P) Localized around the nostrils, but not definitely; it was more a reference than a localization. (Fur 20 P) It's diffuse over the whole body; but when I recall it, it has no relation to the body at all, I don't know where it is. (Rose geranium 20 U) If I look at it and try to localize it I can't, but casually it seems inside and growing. (Glue 20 U) It is diffuse over the body, over the surface of the body maybe, I'm not sure. It's not deep, it's not down in, seems to be over the surface.

Observer Br

(Chord 2 P) I can't tell just where it is bright, but just all over. (String 2 P) The affection is just nowhere, you can't tell where it is; but the tickle, you know where it is. (Vinegar 2 U) I don't know where it is. (Chord 3 P) I don't know just where.

Qualitative Variation

We saw above that the *O*s do not, in these experiments, report qualitative variety of P or U.

It may be worth noting that there is not, either, a single report of qualitative variation within the 'expanse' of a given P or U. There are one or two reports of identity of quality.

Observer H

(Fur 28 P) Qualitatively there is no difference between the central and peripheral parts. (String 34 U) The quality was uniform throughout. It was decidedly more dense at its central part.

Observer B

(Fur 23 P) The P isn't any different, but the experience as a whole unified.

Affection as Tied Experience

The reports already quoted show abundantly that our *O*s do not find affection occurring in independence of sensation. Sometimes, it is true, the affective part of the total experience is so completely dominant that the sensory part has to be looked for, as if by a shift of attentional direction; the *O*s seem to be clear, however, that the looking is for the sake of re-identification and that they were all along aware of 'something sensory' in the background. Very occasionally we get reports that might be interpreted as implying an independent occurrence of P or U; but these reports, aside from the fact that they are few in number, are also in every case equivocal. Under our conditions,

then, affection appears as tied experience. At the risk of repetition we quote a few more reports.

Observer H

(Chocolate 3 P) I don't get hold of that affection in an isolated form. (Sweet orange 4 P) I can't get hold of the affective part in isolation through attention. I don't know why. All the way through I think my attitude is set to carry out instructions. (Glue 4 U) The U belonged to the focal complex. (Glass 5 U) I didn't succeed in isolating the affective experience. (Cold steel 7 U) They were practically separate, but both were there. I couldn't rule out the sensory stuff, but there is no doubt that something gets separated out in the experience. (Caryophilline 7 P and U) The U I was able to get hold of more intimately than the P, but the U was never isolated from the total mass. (Egg 8 P) Then I shifted to the attitude of trying to get P isolated. At all times the sensory part of the experience was there, but it wasn't very clear for observation. (Caryophilline 9 P) The odor was aways there, somehow beaten up with the affective stuff. (Fish soap 10 U and P) It had a slight olfactory tinge, but the major portion of the experience was what I call U. (Vanillin 11 P and U) In the last part of the experience the olfactory part was very weak; there was a hint of odor almost as though the P itself was odorous rather than the odor being there, tangible in experience. (Tansy 11 U and P) The affection came out more clearly as experience, but was bound up with the olfactory part. (13) Question:[4] Can you give any outside analogy to the inseparability of the affection and the sensory content as you report this? Answer: Nothing that is at all times exactly like it. There are times when the fusion of warm and pressure or even cold and pressure is much the same. For the most part there is this difference: that in warm and pressure (warm and pressure and cold and pressure are much the same) these are more unitary; I mean that I can, in the case of the affective-sensory fusion, say that part of it is a specific sense quality, such as smell, and part distinctly not that. It is like the fusion of two different kinds or modalities; so I can break them apart; whereas, with warm and pressure it is more of a piece. One can only say a 'warmish pressure' or a 'pressury warm.' They're bound up together. The nearest approach to being bound up is in the smell-affection; but this differs in that one element seems to predominate.

Observer B

(Caryophilline 17 P) The odor is still a factor, but it is an odor with a great deal of accompaniment. (Glass 18 P) There is a curious unification of all the experiences of the moment when it is P. (Vanillin 18 P) The odor seems to go out to the limits of the expansion too. It is beaten up through the whole thing. (Guiacol 20 P) It was something built around the resinous aspect of that odor or added to it.

Observer A

(Egg 8 U) It seemed that this U belonged to the total experience. (Needle 8 U) The whole experience was U-toned; U went over the whole thing. It didn't make the prick more or less, but colored it all. (Mustard 9 U) Closely bound up with the odor. (Fur 19 U) U stands away from the sensory stuff more than P does, not in terms of space, but in that you can come nearer abstracting it. (String 19 U) It was closely connected with the tactual stuff. (Glass 20 P) The affective experience seemed connected with the touch. The touch is there all the time.

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[4]This question, put at the end of an experimental hour, was the only question asked of an *O* by *E* in the course of the investigation.

Observer N

(Vanillin 6 P) The experience came as a total. (Bergamot 16 P) All the way through I had to attend to the floweriness. I'm so used to attending to the experience as a whole that it is hard to break them apart. (Loose fork 16 U) The U formed quickly; but all the time, with it, was the sound. I don't think they were ever separated. (Opal 16 U and P) That was entirely wrapped up with the sensory experience, both the P and the U. The affective side depended on the sensory experience. (Asafoetida 16 U and P) Sensory was mixed all through; it turned to imaginal. (Chord 16 P) The sound is just as prominent as the P. (Glue 20 P and U) Neither the P nor the U is entirely independent of the sensory part of the experience. (Loose fork 20 U) They are beaten up together.

Observer M

(Glue 19 U) The sensory experience is always there. (Asafoetida 19 U) No matter how much you attend to the U, there is still that sensation there with it. (Ammonium valerianate 19 U) It was tied to the sensation in the sense that the sensation has to be there in order for the affection to be there.

Conditions of Affective Arousal

To arouse an observably affective experience the stimulus must be mildly intensive, not so intense as to arouse a perceptive experience, and the *O* must maintain a psychological, nonperceptive attitude. The attitude may be active within these limits.

Experience from every sense department may take on the increment of bright or dull pressure, that is, may become affective experience.

Every *O*, except A, reported both P and U with sensations from every department of sense. A reported them with sensations of smell, taste and touch. As we stated above, A left the university before the completion of her series, and had no opportunity to observe with visual or auditory stimuli.

Observer H

(Salt 2) Somehow the quality set up an expectation for U, and there didn't seem to be any U there. I rather set myself for the U, to try to get it, or to be sure to pounce on it when it came; not to create it, of course, but get it as soon as it came in. I don't know what the effect of that was. There was then a shift of attitude again, a sort of a naive letting-it-run or something like that. Then U came in. (Needle 3) The experience, as such, caught the attention. The affective experience almost dropped out. Then I shifted again to a naive attitude or a less critical attitude, an attitude of letting a thing be what it will without too close scrutiny; then the U came in. (Hot steel 5) As soon as I turned to the experience, and looked at that experience itself, as if saying 'Is this affection?' there was not much there, if anything at all. (Needle 7) So far as affective it was slightly P; but there was a suggestion that it might become U, and this kept me where I couldn't give up to it; so I can't say anything about it. (Vinegar 11) For a long time I didn't fulfill instructions, I couldn't get it. I was so concerned with the stimulus, I found the taste quality so intense, so demanding, that it was difficult to do much with the affection. (Tansy 11) There was more or less meaning, object-consciousness, mixed up in the whole thing. The affection, as such, didn't become clear. (Rose geranium 31) U, at a certain degree of intensity, shifts over to an emotion. Object-consciousness is more apt to come in.

Observer B

(Chocolate 3) That wasn't even P, when I face it as taste. I never enjoyed good candy less. I believe you have to take these things casually to get anything like P. (Jasmin 9) If I'd let myself go to that, I'd get P. I spoiled it by being analytical. (Caryophilline 15) That was pretty indifferent. There was something in my attitude, an interest in the odor, that spoiled that. (Caryophilline 17) Whatever happens when the odor is P depends a lot on attitude. If I'm too critical, it spoils it, gives me odor only. What I mean by critical there is a predetermination to observe sensory quality; and if I'm set for sensory quality I don't get P. If I take some other attitude, let the quality be hanged, then it is possible for the experience to pass into this stage of expansion, surging. The odor is still a factor, but it is an odor with a great deal of accompaniment. (Ammonium valerianate 19) To get the P it seems necessary to relax or let go. (Caryophilline 21) The odor is a bit weak. I had to observe myself get the odor. That was almost enough to kill the tendency for the P to come. Once there was a shift to the usual conditions and that happened, too, just at the time I let the odor run its own course and took a passive attitude toward it. It depends too on the bodily tension, I think. It gets pretty complicated; but it wouldn't come right if it didn't come easily. (Rose geranium 23) I can feel the increment melt away when I set out to get the odor. Then I can relax, and the experience will solidify and thicken right up. (Flicker 30) That came when I had an unspecific attitude toward the stimulus, and it was soon over. Looks as if the *thing* is damaging to the experience. (Colored strip 30) When I began to pick out the R, Y and B that were best in saturation, it began to lose the buoyant soft pressure that was P, and was just colored stripes.

Observer F

(String 27 U) Very difficult to observe; the experience is so intensive. (Flicker 43) I didn't get any affective experience at all. I was too intent on seeing what the stimulus was. There were so many changes of hue and form that I took the experience as an interesting novelty and failed to observe the affective side of it.

Observer A

(Jasmin 5) All these smells I'm afraid of when I first smell them. I question them first. I'm stiff. The sweetness was the first thing, and then I relaxed. (Glue 6) I can't say anything about the first U, because there was just the stimulus. (Vanillin 9) When I tried to give my attention to the P, I found my attention on the quality of the odor. (Juniper 10) I wanted to give my attention to it and had to find it, get it out of the complex. As I did that I was searching for it. What I got was just the quality of the experience, not other things. (Guiacol 12) I don't think it was either P or U. I used to hate that smell, but it doesn't seem U now. I'd say it was an U odor, but I couldn't find anything in the experience that was affection. (Bergamot 17) I couldn't find anything. The pungency localizes the thing at once, so attention gets on quality of the thing and no affection comes. (Needle 25) As far as I can tell there wasn't any palpable affection there. There might have been, but I withdrew from it, and that was all I could attend to. It very decidedly *meant* U. It meant that it hurt and it would hurt more if I didn't get away. If there was any affective stuff there I didn't know it, but there were a lot of organics, jumping, etc. (Crackling 29) Gee! It meant U; I don't know if there was any palpable U there or not.

Observer N

(Rose geranium 11) Nothing. I identified it the first thing, and could not get anything. (Sandpaper 14) There was a decided sensory experience, but I can't say if P or U. (Colored strip 16) I don't get anything there. I made that, and I did a poor job; the imperfections jump out at me.

Observer By

(Wormwood 20) That was neither P nor U. It's strange and new. (Vanillin 18) I can't give any account. I was too much interested in the new way of presenting it. (Flicker 16) I haven't seen that often enough for the novelty to wear off. Every once in a while it would begin to get U, but it wouldn't stay U; my attention kept going back to the stimulus. (Opal 16) I can't do anything, I don't know why. I know it's P, but I'm looking for something.

Observer Br

(Colored strip 1) I get the affection better if I look just a short time and then stop. It comes after I stop looking at it, and it seems, when I look away, that it has no shape; it's just there.

The Incompatibility of P and U

In all of our experimental work there is not a single case of mixed feeling reported. There is only one reference to such a possibility.

Observer A

(Citronella 11 P and U) "At first I thought I had mixed feelings." The report is very long, but there is no other reference in it to mixed feelings. There was an U experience cutting across an otherwise P experience. The *O* reports positively that while it was U it was not P: "The U would cut across just as the P was gone, so I couldn't compare the U and the indifference."

Conclusions

We have tried, in the foregoing pages, to exhibit our data as nearly as possible in the way in which we received them. We have used the terms 'sensory' and 'affective' in the ordinary sense, as they were used by our *O*s; we mean them to be taken, without prejudice, merely as labels. We do not, indeed, venture at this time upon any sort of systematic discussion of our results; the results themselves—which were as unexpected by us as they will probably be strange to the reader—must, we think, first be tested by other experimenters; and many questions of affective psychology which our investigation does not touch must first be asked and answered. We believe that the reports which make up the body of this paper will help materially to stabilise affective doctrine, and so to settle one of the major uncertainties of experimental psychology; but we do not pretend to have done more than break ground. We therefore postpone systematic considerations;[5] and for the same reason we do not at present attempt to review the work of our predecessors, and to bring earlier results into line with our own.[6]

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[5]We remark only that there is a certain plausibility about the reference of P and U to the modality of touch, since other touch qualities (tickle, itch, pain) are connected with gross reflex movements. We do not know, however, that the bright and dull pressures which are P and U are peripherally aroused.

[6]Cf. E. B. Titchener, *Elementary Psychology of Feeling and Attention*, 1908, Lect. iii.

The outcome of our enquiry may be summarised as follows. Every item of the summary must be qualified by the phrase "under the conditions of the present experiment."

(1) Sensory experience may or may not also be affective; it may be characterized as P or U or neither. If sensory experience becomes P or U, it alters as a whole; something is added to it that is not present while it remains indifferent.

(2) Qualitatively, this increment, in the case of a P experience, is bright pressure or a touch-quality lying between bright pressure and tickle; in the case of an U experience, the increment is dull pressure or a quality lying near dull pressure.

(3) The bright pressure is more extended than the dull pressure of the same general intensity, and is usually greater in extensity than the accompanying sensory experience. Both P and U may vary in extensity. P is very voluminous, without limit or restraint. U is voluminous, but less so than P; it is without limit, but is somehow constrained or contracted. Neither P nor U has definite form, limit or boundary.

(4) The affective increment is sometimes beaten up with the rest of the experience, and sometimes there is a quasi-spatial separation, which, however, is never complete.

(5) P and U are both inherently weak, mild; but they may vary in intensity. The *O*s do not, at all times, report changes in the same variable as intensive changes. The 'intensity' of P may increase as the brightness increases, as the volume increases, with the increase of some variable in the nature of chroma, or with the intensity of the stimulus. The 'intensity' of U may increase as the dullness increases, as volume decreases, as density increases, or, again, with increase in the intensity of the stimulus.

(6) There are patterns of density for both P and U. P shows streaks in a roughly radial direction, and is more dense, more intense, more prominent or more dominant somewhere out from the center, toward the periphery. U is more prominent at the center. Both dwindle at the extreme limits, though there are no definite limits in the sense of boundaries.

(7) At a high degree of intensity affective experience becomes perceptive and, in the case of U, passes over into emotion. This passage was not reported for P.

(8) The affective component of an experience goes on at the same time with the sensory component. It rises after the sensory component; P comes in gradually though quickly, while U comes in at full strength. Both P and U run a course, which may be either continuous or intermittent, and disappear with or before the sensory (or imaginal) component.

(9) Affection is palpable; it stands up under observation.

(10) The affective component is not definitely localized. Usually it is not localized at all. It may, however, be vaguely localized as within the body, or as projected out from the body; or it may be referred to some more or less well defined part of the body. There is some evidence to show that whenever affection is dominant for attention there is no localization.

(11) Neither P nor U appears in isolation. The affective component ties up, under various aspects, to the sensory component of the total experience.

(12) Affection is not simply a meaning carried by organic sensations. Nor is it a blend of organic sensations.

(13) Experience from every sense department may take on the increment of bright or dull pressure, that is, may become affective experience. To arouse an observably affective experience the stimulus must be only mildly intensive, not so intense as to arouse a perceptive experience, and the *O* must maintain a psychological, non-perceptive attitude. The attitude may be active within these limits.

(14) P and U are inherently alike, as if made from the same matrix. Their differences are of the sort that occur within one and the same modality.

(15) There is no qualitative variety either of P or of U. Nor are there qualitative differences within the spread or volume of a given P or U.

(16) P and U do not occur together; they may appear in rapid alternation.

BEHAVIORISM AS A MONISM OF ACTION

By Oliver L. Reiser, Ohio State University

With the current overhauling of the postulates of the physical and the psychological sciences, there is a growing conviction that the time is approaching for scientists to coördinate such results as they have already secured in their respective fields, in an attempt to arrive at that unified outlook which philosophers have termed the synthesis of the sciences. Progress in science is continually demonstrating the truth that no science liveth unto itself, and this further indicates the necessity for coördination, because of the fact that psychology has hitherto been based upon an inadequate philosophy of physics, while the psychology of most physicists is obsolete.

The thesis of the present paper is that the line along which this reconstruction is to be sought lies in what may be termed *universal behaviorism*, the pivotal conception of which is a *monism of action*, rather than a physical monism based upon an antiquated mechanistic materialism. The best presentation of the concept of physical nature consistent with this point of view is that of A. N. Whitehead in his various expositions of the subject of relativity. With the new concept of physical nature, however, we are not at present concerned.

The outstanding hiatus in the biological sciences is the introduction of dualism into psychological explanation. The concept of mind is introduced to explain such complicated activities as volition, purpose, reasoning, *etc.*, which are difficult to reduce to monistic terms. The most effective way of understanding why human beings do the things that they do is to view consciousness and human behavior in the light of their developmental sequence; and a survey of the evolution is therefore the best approach to the establishing of a monism of action in the field of psychology. This is the purpose of the present essay.

The Evolution of Behavior

In some way, probably through the influence of sunlight, the simpler organic colloids have been synthetized into the more complex protoplasmic systems, which form the basis of life. We may obtain some notion how living matter may have taken its origin in the sea from the work on the formation of formaldehyde and the sugars by the action of light of short wave-length on carbonic acid and water. Assuming that the characteristic phenomena of living matter, irritability, metabolism, growth, reproduction, *etc.*, are forms of chemical behavior which accom-

pany protoplasmic systems,[1] we may next consider the evolution of these behavior-complexes, with the end in view of discovering the principles underlying the synthesis of mind.

In the face of the mechanistic assumption that structure determines function, it is usually held that the study of the evolution of behavior is less advanced than the knowledge of the evolution of structures, and that the correlation between structure (morphology) and function (physiology) is still to be worked out. In the present essay we are interested mainly in the evolution of behavior as dependent upon neural integration; but since this form of correlation arose naturally out of chemical regulation, with its axes of polarity, *physiological gradients*, or *growth potentials*, we must observe in what manner it has profited organisms to possess this added perfection.

The irritability of living tissue is the beginning of the stimulus-response relation, and irritability is a property of unstable chemical compounds. This relation, as a fundamental property of living matter, has its origin in the unicellular organism wherein specialization of tissue has not yet taken place. The manner in which protozoa or unicellular organisms developed into metazoa or multicellular organisms is not understood, although it is at once obvious from the principle of cell division—that the division-spindle of the cells tends to divide at right angles to the longest mass of the protoplasm—that the inequality of growth in the three possible dimensions of space will account for all the forms which organisms can take. Why cells should divide and multiply is a matter which colloidal chemistry may some day reveal.

It is well known, of course, that the less specialized a cell is the greater is its versatility in assuming the obligation of different functions. The simpler organic forms still preserve this plasticity of functional adaptation. In this connection it is noteworthy that several investigators who believe that they have demonstrated the inheritance of acquired characteristics on the basis of results wherein the sex of an organism has been changed seem to be overlooking the fact that, while sexual dimorphism took its origin in the protozoa, a number of the lower organisms are potentially bisexual, and that it takes but a small change in the developmental factors—nutrition, for example,—to make them male or female.

The Evolution of the Nervous System

In the lowest metazoa the coördination between the different cells of the colony is secured through chemical means. Thus the sponges have no nervous system, but they function somewhat as

[1] O. L. Reiser, Life as a Form of Chemical Behavior, *Monist*, 34, 1924, 150-160.

if they had. That is, there are muscle cells, sensitive to stimuli, which play the dual rôle of receptors and effectors. The stimulus is transmitted slowly by what is termed "neuroid" conduction (G. H. Parker). In the sea-anemone we find both nerve cells and muscle cells, thus providing the basis for reflex action.

The 'nerve-net' type of organization, consisting of a continuous net of nervous tissue, which is found, for example, in the coelenterates, is the more primitive type of neural coördinating mechanism. From the evolutionary point of view, the nerve-net seems to have given way more and more to the synaptic system of nervous organization, which is held to allow anatomical independence to the individual neurones. But the two systems are by no means exclusive of each other, for they may both exist together within the same organism. The nerve-net still persists in vertebrates, and controls the vegetative processes, such as are connected with the smooth musculature, where the autonomous character of the action is still preserved. Indeed, some investigators argue that the central synaptic system is still subordinate to the autonomic nervous system, and is only concerned with securing a maximum gratification of the emotions, which seem to be largely dependent upon the activities of the smooth-muscle and glandular systems regulated by the autonomic ('sympathetic') nervous system. With the development of the synaptic system, with its neurones functioning as relatively independent units, there is provided the basis for reflex action, consisting anatomically of a sensory, a motor, and a connecting or correlating neurone in the spinal cord. The ganglionic system which develops in the segmented worms increases in size at the anterior end to form the brain. The belief that consciousness appears with the development of the central system, and arises at the juncture of the cortical neurones of the cerebrum, rests upon the fact that the processes controlled by the autonomic nervous system of the vertebrates, which corresponds to the nerve-net of the lower organisms, are normally unconsciously performed.

Unlike the development of the nerve-net in the invertebrates, which develops from within, the evolution of the neuronic system of the vertebrates, or the cerebro-spinal system, is formed by an invagination of the ectoderm to form the neural tube. Three vesicles are formed at the anterior end of the central nervous system, with the ventricles thus produced filled with the cerebro-spinal fluid, while the posterior end, the spinal cord, preserves a segmental character, with the spinal nerves issuing in pairs along the vertebral column. The bending of the vesicles, the fore-brain, mid-brain, and hind-brain, gives a greater length in a smaller volume, and the anterior vesicle is thereby permitted

to develop to such an extent that the cerebral hemispheres, in time, come to cover the rest of the brain enclosed within the cranial cavity. The cortex, the outer rind of the cerebral hemispheres, is the wall of cell bodies constituting the "gray matter" of the brain, which is somehow formed by an evagination of the neural tube.

The foregoing may serve as a rough sketch of the development of the structural aspect of the central integrating mechanism of the higher vertebrates. The functional importance of the nervous system will be considered after we have surveyed in an equally brief fashion the evolution of receptors.

The Evolution of Receptors

Organisms maintain their existence by adapting themselves to changes in the external world of things and events. They are the better provided for their adaptations to their environments in proportion to the number and variety of external phenomena to which they are capable of responding.[2] A perfect organism would have a solution to every problem, as adequate response to every stimulus; the whole universe would constitute its environment. In man alone do we find any approximation to this condition of universal adaptability.

All higher organisms are protected by some sort of shell or cuticle from excessive stimulation from without. Later on individual parts of the surface are then differentiated in such a way as to be sensitive to only one group of excitations, while remaining insensible to all other forms and frequencies. The lower organisms are sensitive to chemical, thermal and light changes, and their responses, known as *tropisms*, are impelled by these forms of excitations. The stimuli that are of an injurious nature were probably responded to first of all. A current theory has it that in human beings these receptors for nocuous stimuli have survived in the free nerve endings in the skin, which give us pain sensations.

Since the most primitive organisms lived in the sea, they would naturally be exposed to a variety of chemical substances dissolved in water. It is found, for example, that the skin of a fish is sensitive to acid, alkali and salts; in many cases the hydrogen ion concentration is the important factor. The senses of taste and smell are higher developments of this primitive chemical sense. Touch receptors were later developed into the present elaborate apparatus for cutaneous sensations.

In a general way, advance to higher levels of response is correlated with an increasing prominence of vision and hearing,

[2]In the following account of the evolution of sense-organs I am indebted to the treatment in W. M. Bayliss' *The Principles of General Physiology*, C. S. Sherrington's *The Integrative Action of the Nervous System*, and C. J. Herrick's *An Introduction to Neurology*.

with a diminution of importance of the other modes of sensations. The eye and the ear are the principal "distance receptors," and the development of vision, which has been called "anticipative touch," has so accelerated the progress of evolution that man has well been called a "space-eater."

In its origin the function of the sensory apparatus was probably to serve as an adjunct to the motor system; but in the present highly elaborate sensory system, in which vision and audition are the most important modes, sensory stimulation has become an end in itself. Aesthetic experience, its own excuse for being, illustrates the general detachment of human activity from its original utilitarian, overt behavior-value.

As we have seen, the function of the receptive cells is to pick out from the mass of different movements in the environment constantly impinging upon the organism those to which the specific sense-organ is attuned. Each sense-organ is irritable to its own adequate stimulus. In this way, the environment is split up so that only parts of it need to be reacted to at any one time. The whole process of the evolution of receptors consists in the development of sense-organs for purposes of action, so that the objects of nature take on sharper outlines and distinctness. This is the position which Bergson defends in *Creative Evolution*, when he argues that the geometrizing intellect has been developed for purposes of action upon objects in space. If we take the cerebrum, which has been evolved around the distance receptors, as the seat of "thinking," this view gains plausibility. The paradox which any such evolutionary theory encounters is this: Did the brain, which is the center of reference for perception and conception, thus, in a measure, "create" the external world, as we know it, or did the external world create the organism and its sensory and motor apparatus? This, of course, raises the whole question of the "causes" of evolution. Lamarck, Driesch and Bergson believe that we must assume that evolution of structure can not be explained without postulating some inherent, striving principle, which, through its adaptive efforts, causes the individual structural modifications, which are preserved and passed on. Orthogeneticists also point out that these variations may persist, in spite of the fact that they have no apparent use at the time of their inception, and only later take on survival value after a number of such variations, persisting in a definite direction, have assisted each other, so to speak. One illustration of this is the gradual modification of the jawbones, so that one of the bones drops out from the structures used in chewing, and comes to be pushed up into the middle ear cavity to function in the transmission of sound-waves from the ear drum to the inner ear.

To the present writer the most tenable doctrine is that neither the sense-organ, nor the brain, nor Bergson's geometrizing intellect at home in a world of solids, has created the sharply delimited bodies of the external world. On the other hand, the organism is not the passively moulded product of the external forces of the universe. Rather, both the organism and externality, as we humans know it, have developed together by a give-and-take in which conceptual interpretation, supplementing perceptual experience, has partially created the forms of external nature, and, in turn, the objective order has forced us to readjust our cerebral behavior ("ideas") to its (the environment's) semi-determinate texture. Through the vast span of time in which this process of mutual intercourse and interadaptation of organisms and their environments has progressed, the environment has continued to take on a more articulate character, while the organism has continued to develop an apperceptive synthesis which it has superimposed upon the external universe, the ultimate structure of which may be unknowable. I assert this not as a student of biology, but as a bystander who watches with interest the attempts of the relativity-physicists to determine whether or not the objective universe is a non-Euclidean space-time continuum, and the attempts of the psychologists to ascertain whether the ability to build up a meaningful universe arranged according to the forms of space and time is innate or acquired. This is not saying that the mere presence of a thinking organism makes the form of electrons different from what it would be if the scientist did not exist; but it does imply that the question of what the shape and mass of an electron-in-itself may be, independent of the presence of the physicist, with his sense-organ and precision-instrument equipment, is an insoluble riddle.

Before dismissing Bergson's teleological conception of evolution it may be profitable to discuss the question of vision as a special case of functional adaptation, inasmuch as it may throw some light upon the mechanism, the human body, the superlatively intricate operations of which have always elicited the wonder of those with vitalistic prepossessions.

Functional Coördination

As an illustration of how the vital impetus, ramifying through the divergent lines of evolution, may manufacture like apparatus by unlike means, thus transcending the mechanistic principle that like effects must have like causes, Bergson cites the development of the eye of the Pecten, a mollusc, and the vertebrate eye. Here we have homologous structures developed in two species which had separated from the parent stem long before the appearance of the organ of vision. The problem which this presents to the mechanist is that of explaining how acciden-

tal causes (random variations), occurring in an accidental order, can have repeatedly come to the same result, the causes being infinitely numerous and the effects infinitely complex.

The eye is complex, being constituted of a number of parts so functionally interdependent as to seem to have been designed for the very purpose of vision. How is this correlation of functions to be explained? The theory of selection from chance variations in all directions does not explain how the parts of the visual apparatus remain so coördinated that the eye continues to function effectively. To speak of sudden variations or mutations only makes the problem more difficult. That a change in the germ-plasm influences the formation of the retina, cornea, iris and lens at the same time is conceivable; but that all these simultaneous changes should occur in a way to improve or even maintain vision is not admissible.

Another way of accounting for the appearance of the eye is to suppose that variations are due, not to accidental inner causes, but to the direct influence of outer circumstances. Though the molluscs and vertebrates have evolved separately, both have remained exposed to the influence of light. The resemblance of the two effects may be explained by the identity of causes: light acting directly upon organized matter so as to change its structure, and somehow to adapt this structure to its form. But, Bergson argues, the term adaptation is ambiguous. In one sense it means the receiving of an impress from the outside; in another sense it is a positive reaction, a solving of a problem. It is in this sense of the word that we say that the eye has become better and better adapted to the influence of light. Nature herself appears to invite a confusion of the two kinds of adaptation, for she usually begins by passive adaptation, where, later on, she will build up a mechanism for active response. Life adapts itself to matter at the outset, and later directs the movement it adopted.

When we say that the eye makes use of light we do not merely mean that the eye is capable of seeing; we mean the precise relations that exist between this organ and the apparatus of locomotion. The retina of the vertebrates is prolonged into the optic nerve, which is continued by cerebral centers connected with motor mechanisms. No one would hold that light has physically caused the formation of the nervous system, or of the muscular system, all of which is implicated in the usefulness of an eye. According to Bergson, whether we will or no, we must appeal to some inner directing principle in order to account for the convergence of effects.

I have entered into this exposition of Bergson's theory to afford a starting-point for a few remarks concerning the problem of correlation of functions of different structures. Accepting

Bergson's criticism of mechanism, in so far as mechanism rests upon a confusion of the abstract time of physics, which is a "phantom" of space, with the concrete duration of what A. N. Whitehead calls "the creative advance of nature," we must, at the same time, reject the *élan vital* as the cause of evolution. Bergson's arguments for vitalism rest upon the inability of science to explain certain mysterious results, and illustrate the danger of this mode of argument,—for the progress of science consists in finding "mechanical" solutions to the problems which were formerly taken as an excuse for the introduction of non-natural agencies. (I use the term "mechanical" under protest, for it is doubtful whether it can be defined in a satisfactory manner.)

More recent work on the mechanism of correlation and functional interdependence may help the biologist to understand many of the phenomena which have hitherto seemed baffling. The results have been summarized by A. Keith[3] in his Huxley Lecture on "The Adaptational Machinery Concerned in the Evolution of Man's Body." In the case of vision the researches of W. H. Lewis have shown how the optic cup, which ultimately forms the retina of the eye, grows from the wall of the brain towards the embryonic skin or ectoderm. "When this cup comes into contact with the ectoderm, the underlying cells begin to proliferate and arrange themselves so as to form a transparent crystalline lens. Dr. Lewis transplanted the outgrowing optic cups of tadpoles, and found, if they were placed under the ectoderm of the neck or belly, that the result was the same; an optic cup caused the underlying cutaneous cells to alter their nature and form a lens. Dr. Lewis realized the significance of his discovery; in the developing embryo, although only of certain species, one group of living cells can enslave and control the behavior of another group. He gave us a glimpse of the kind of evolutionary machinery employed in fashioning a highly purposive structure such as the eye."

These results on the regulatory influence of one group of cells on another, which holds between spatially distinct cell-groups of the cortex of the brain as well as between nerve fibres and their muscular termini, are of great interest in connection with the phenomenon of chemical substances and ferments (*hormones, autocoids, etc.*) passing from one structure to another to influence the behavior of the latter.

The theory of hormones, which J. J. Cunningham has already applied to the problems of heredity, may have to be extended to include the field of botany; for there is evidence that in plants the transfer of stimuli from the receptive to the motile

[3] *Nature*, 112, 1923, 257-268.

regions is effected by the passage of "chemical messengers." Of whatever value such speculations concerning hormones as "formative stimuli" and as bearers of racial memories may be, such illustrations of chemical integration and regulation are of value in warning us against the hasty conclusion that no mechanism is conceivable which will enable us to understand the phenomenon of functional interdependence and organic intra-adaptation. In connection with the role of biochemistry in genetics the results of M.F. Guyer[4] and E. A Smith are especially noteworthy. Guyer and Smith injected into pregnant rabbits serum from the blood of a fowl, into which extract from lens-tissue of rabbits and mice was introduced, with the result that the lenses of the embryonic rabbits were attacked and the young showed defects of the eyes, which persisted in the second generation of rabbits in which no injection was made. Aside from the bearing this may have on the question of the possibility of modifications of the individual germ-plasm producing a racial effect, there is the interesting question whether there is any relation between the effects of the toxic action of the anti-bodies and the chemical regulation of the organs of the body by hormones.

Cerebral Behavior

Having surveyed the evolution of receptors and the central nervous system as the correlating mechanism which connects sensory and motor points of the body, thus through its coördinating operations securing harmony of action of complicated receptor-effector patterns, we are now in a position to attempt to fit what may be termed either cerebral or mental behavior into the general notion of a monism of action. The supreme importance of the nervous system in behavior is obvious to all students of biology. It provides for variability of response, for harmony of action in adjustments which involve extremely complicated sensori-motor configurations, and is the basis of "intelligence," which may roughly be defined as the ability to learn by experience. Intelligence is the capacity of bringing relevant past experience to bear in adjustment to the novel situations which constitute the problems of organisms. This seems to be largely a problem of complexity of neural tissue.

That intelligence is not peculiar to man, but has its beginnings early in the ladder of evolution, is evident from experiments on lower organisms such as have been conducted by H. S. Jennings. Intelligence has its origin in the "trial and error" learning or experimental behavior which is found in the Infusorian. Thus the Slipper Animalcule overcomes its obstacles by reversing the action of its cilia, backing away from

[4] *Journ. of Exp. Zoology*, 31, 1921, 171.

the obnoxious stimulus, and advancing again on an angle slightly diverging from the original axis; and the Stentor solves its problems by selecting the appropriate response from its behavior-repertoire.

Higher organisms come into the world with an inherited set of responses, and it only takes the appropriate stimulus to release the adaptive adjustment. There has been and is much dispute concerning the definition of these supposedly inherited modes of adjustment. Instincts have been defined in various ways, but none of the definitions has proved generally acceptable. The consequence is that some students have gone so far as to deny the existence of specific instincts.

There is also the question how instincts, if any, have been built up, the same problem arising again which has refused to be put out of court, *i. e.*, whether instinct is "lapsed intelligence" in the sense that it represents the persistence of a mechanized form of action once purposively and consciously performed, or whether the evolution of behavior is the evolution of structures, determined by principles in which the inheritance of acquired characteristics plays no part. This problem of the relation of intelligence to instinct has been a fertile field for controversy for many years. On the anatomical side we find the main dichotomy to lie in the difference in size of the cerebrum: instinctive behavior reaches its highest development in ants, bees and wasps, whose "little-brained" nervous systems stand in marked contrast with the "big-brained" mammals, with their consequent intelligent behavior. It is for this reason that I have designated *mind* as a form of "cerebral behavior." However, the integrity of this supposedly clearly defined difference between instinct and intelligence is threatened by the development of the doctrine of the *conditioned reflex*, the purport of which is the reduction of all learning to the status of acquired responses which are conditioned on reflex behavior in such a manner that the factor of intelligence becomes a name for neurone and synaptic factors such as "modifiability," "retentiveness," *etc.*

From the point of view of a monism of action, what needs to be pointed out here is the reason why people do the things that they do. If we accept, what many geneticists take to be a fact, that so-called "mental traits" are inherited, then we must start from the position that in some way or other there are potential pathways of response already laid down in the nervous system, even in the child which, in its early infancy, has not modified to any extent these inherited tendencies to reaction by alteration of the resistances of the cortical patterns (if inherited mental traits are there localized) by training or experience. All subsequently acquired reactions modify these pathways, but what

we can learn is, in turn, determined by the original inheritance. What I am, then, is the sum total of all my inheritance *plus* the modifications due to experience. The factors, therefore, which determine which way a nervous impulse will go when it reaches the cerebrum are *heredity*, *habit* and *fatigue*. The doctrine that the mind, as a non-biological entity, acts as a kind of switchman, standing at the cortical synapses, shunting trains of nervous energy over this or that track, meets with insuperable difficulties.

There is another theory which is of value in connection with the doctrine of learning as a process of establishing conditioned reflexes. This is the theory that cerebral nervous impulses tend to irradiate over a number of pathways, and that it is only through repeated behavior that a definite response is linked more or less automatically with a definite stimulus by the formation of a "final common path." The hypothesis of irradiation is interesting because it suggests the mechanism whereby the "collateral ideas," which normally serve as a check upon behavior, are inhibited by "suggestion." This also throws some light upon the matter of belief. It is well known that the judgment of an expert with a wide experience is much more accurate and immediate in his own field than is that of a novice. Both belief and readiness to act depend upon the resistance, or lack of it, which an idea meets with in the individual. This past experience may be stored as brain patterns, if we regard *ideas* as rearoused *percepts*, and under normal conditions any idea tends to call up the relevant ideas associated with it. Suggestion, hypnosis, fatigue, narcosis and toxic conditions are circumstances in which these collateral ideas are temporarily banished from consciousness, and can therefore no longer serve as checks to inhibit ideas or behavior which normally would be regarded as abnormal and ridiculous by this same individual. These conditions eliminate these inhibitory ideas by draining the nervous flux, which ordinarily tends to irradiate and arouse the collateral patterns, into one channel which is thereby strengthened.

While the physiologist does not fully understand *facilitation*, *inhibition*, and the "drainage" of nervous energy, all of which are involved in the psychological phenomenon of *attention*, and can not say just what happens at the synapse, there is no reason for supposing that when the explanation is forthcoming it will be given in any other terms than those which have always been connected with progress in science.[5] The advantage of the preceding view seems to be that it provides a mechanism for the understanding of individuality and of "multiple personalities"

[5]The difficulties which confront the psychologist who is concerned with the intellectual aspects of human conduct I have pointed out in an article "The Structure of Thought," *Psychol. Rev.*, 31, 1924, 57-73.

as complexes of patterns of ideas and feelings, which may split up into separately functioning individuals, if the integrative action of the nervous system is not sufficient to unify these clusters of sub-individuals into a "personality."

In the preceding account I have emphasized the neural conditions of human behavior. This emphasis upon the nervous system as an autonomous organ of central integration will be regarded by the "behaviorists" who stress the response (effector) side of behavior as old-fashioned. The present position is in accord with the statement of G. E. Smith[6] that "the secret of man's most distinctive attribute (intelligence) is hidden in the texture of his brain, and perhaps will never be fully revealed." To me it seems impossible to stress too much the significance of the nervous system, because in the synaptical resistances is to be found the gradation of energy thresholds, or levels of synthesis, which can account for neurasthenia, senile degeneration and allied disturbances of personality, which consist in the dropping down to levels of response requiring less energy expenditure. It is through some such conception of the evolution of behavior as the progressive integration of levels of reactions that the synthesis of mind is to be viewed.

Physiological Integration and Psychic Synthesis

The tenability of the view herein set forth, namely, that the unity of mind is what might be called an overtone of the individuality characteristic of organismic integration, rests upon the validity of the thesis that there is no opposition between physiological processes and the conduct of mind conceived even in intellectualistic terms. To this end I wish to point out that bodily processes bear the stamp of their subordination to the synthetic character of organic integration of function in the "organism as a whole." If this be true, as I shall briefly argue, then the prime fact of consciousness, the synthetic and purposive character of its movements of abstraction and generalization, is a reverberation of physiological integration through the differentiation of structure and integration of function.

This principle of a hierarchy of levels of synthesis, introducing unity of action through the relation of dominance and subordination between the integrating mechanisms of complex organisms, is being recognized on all sides. That it represents the actual pathway of evolution is pointed out by J. A. Thompson[7] who holds that the clue to the maze of animal behavior "is that there has been at level after level a process of automatization or organization, which makes for economy of time and energy, and also, if it does not go too far, leaves the organism

[6] The Human Brain, *Nature*, 113, 1924, 390.
[7] *The System of Animate Nature*, 1, 1920, 194.

free for experiment and initiative." C. S. Sherrington[8] credits Hughlings Jackson with having pointed out the significance of "levels" of neural machinery standing in the relation to each other of drivers and restrainers.

One of the clearest recent statements of this doctrine is presented by H. Head,[9] who adopts the term *"vigilance"* to express this fact of the functional efficacy of the neural hierarchy. As he says: "There is no more difficulty in understanding how an act of consciousness can affect a physical process, than to comprehend how one reflex can control and modify another of a lower order."

On the basis of experiments on the regeneration of nerves Head and his colleagues have distinguished two different kinds of mechanism on the afferent side of the nervous system. These are (1) the protopathic stage, characterized by the absence of any exactness of discrimination or localization, and by the presence of pronounced feeling tone; and (2) the epicritic stage, which marks the return to the normal spatial perception of exact discrimination and localization. It is probable that these two types of sensibility represent distinct stages in the evolution of cutaneous sensibility. According to Head and Holmes the relation between protopathic and epicritic sensibility is analogous to the relation between the cerebral cortex and the optic thalamus. Furthermore, according to W. H. R. Rivers, who discusses the subject in his *Instinct and the Unconscious*, the relation between these two forms of sensibility suggests the manner in which the suppression of experiences in the individual may recapitulate the racial suppression of earlier phases of evolution.

This conception is of interest because, as Rivers argues, the property of repression arises out of the organization of the nervous system into a hierarchy whereby the higher levels control the lower ones. The hierarchy represents strata of potential behavior, the lower levels representing levels of unconscious experience suppressed in something of the same fashion in which the tendency to affective over-response of the thalamus is inhibited by the cortex. It also suggests the problem how the evolution of the brain as the correlating mechanism through which the unification of tactile and kinaesthetic senses with stereoscopic vision, involving eye-movements of accommodation and convergence, has been secured; and how the synthesis of visual space with the motor space given in the handling reactions has provided the basis for the development of a curiosity in

[8]Some Aspects of Animal Mechanism, *Nature*, 110, 1922, 350.

[9]The Conception of Nervous and Mental Energy (II), *Brit. Journ. Psychol.*, 14, 1923, 126-147.

man for knowledge concerning the world about him. One might carry these speculations so far as to assert that physiological correlates for all of the mystical entities of the psychoanalysts are discoverable. Thus, E. W. Scripture[10] claims to have isolated the voluntary activities underlying Freud's tripartite division of the soul, and to have recorded them on psychological laboratory apparatus.

On the functional side this conception of levels of synthesis is being popularized by the adherents of *Gestalt*-psychology, with M. Wertheimer, W. Köhler and K. Koffka[11] as the outstanding exponents. However, the recognition of qualitative wholes and unitary responses to multiplicity of stimuli as expressive of the phenomenon of psychic synthesis is by no means a new doctrine. While the doctrine goes back to Lotze (perhaps even to Plato) it may be recalled that, in the field of vision, McDougall[12] seized upon this fact of synthesis as an argument in favor of his doctrine that the mind can not be reduced to bodily processes. In the field of audition an excellent discussion of the problem of tonal fusion, such as the "micro-psychic" rhythms of Lipps and Stumpf's hypothesis of "specific synergy," is set forth by R. M. Ogden in his book on *Hearing*. It is the opinion of the present writer that psychologists have underestimated the rôle of unconscious synaesthesia, especially in aesthetic perception. Without attempting to enumerate any further the different variations of this theme which Wundt called *creative synthesis*, we may note that the whole movement seems to be part of a general reaction against the fallacy of over-analysis, which is at the bottom of the *emergent* theory of C. Lloyd Morgan and S. Alexander. So far as the present writer is informed, the best biological explanation of the hierarchy underlying the synthesis of unitary responses is presented by C. M. Childs in the theory of mechanical, chemical and neural integration expounded in his *Individuality in Organisms*, and *The Origin and Development of the Nervous System*.

In the above doctrine is contained the explanation of the relation between consciousness and the nervous system. That is to say, the relation between structure and function, body and soul, and matter and energy, is the homologue of the pervasive correlation between the two mutually complementary conceptions of the static and dynamic, the spatial and the temporal.

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[10]Three Biological Principles Observed in Speech Inscriptions, *Nature*, 113, 1924, 386.

[11]For a summary of this movement see Koffka's article: Perception: An Introduction to *Gestalt-Theorie*, *Psychol. Bull.*, 19, 1922, 531-585.

[12]The Relations between Corresponding Points of the Two Retinae, *Brain*, 33, 1911, 371-388.

THE FLIGHT OF COLORS[1]

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INTRODUCTION

Among the most frequently noted visual phenomena is the series of after-images which follows the fixation of a bright light. It is generally known as "the flight of colors." Although these after-images have been more than an occasional object of experimentation for several centuries, the results have been far from uniform. Berry, in an historical summary of the data, states: "The sequence of the colors in the after-image has varied from one observer to another. Only in one or two cases has there been close agreement."[2] The following color sequences obtained by several experimenters verify this statement:

Goethe—bright, purple, blue, dark[3]
Fechner—blue, green, red, blue[4]
Purkinje—bright, bright red, dark, bright, gray[5]
Scoresby (1)—green, yellow-green, yellow, orange, red, scarlet, crimson, brown or olive
Scoresby (2)—dingy orange, olive, yellow, gray or blue, black[6]
Washburn—blue, green, red, blue-green[7]
McDougall—green, red, blue, green, red, blue[8]
Honmouth—blue, purple, violet, yellow[9]

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[1]From the Psychological Laboratory of Wellesley College. Communicated by C. A. Ruckmick.

Titchener has suggested that the sequence of colors may be due to an alternating excitation of the B-Y and R-G substances with the intermediate effects due to the operation of laws of color-mixture among some of the colors aroused in the the after-images.[10]

The disagreement between the above sequences is typical of other items in the reports. Several authorities have asserted that a stimulus of low intensity does not give colored images,[11] while one of them concluded that the images of any white light were always colored.[12] Goethe, Fechner, and Honmouth reported the advance of colors in the image from periphery to center, while Helmholtz described colors in an image of moderate illumination as irregular in appearance, often advancing from one side of the image to the other.[13] Honmouth, opposed to Goethe,[14] concluded that there are no gradual transitions from one color to another in the image, but that constant rivalry or kaleidoscopic displacement exists among them. Fechner framed the general rule that, whenever the duration and intensity of the stimulus have reached a certain degree, any increase in either does not alter the constancy of the color series.[15]

The present investigation was undertaken partly in view of the disagreement in results of previous experiments, and partly because the data, though divergent, suggested nevertheless certain underlying factors. Seguin, Scoresby, Fechner, Hodges,

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[2]W. Berry, Flight of Colors in the After-Image of a Bright Light, *Psychol. Bull.*, 19, 1922, 333.

[3]J. Goethe, *Zur Farbenlehre*, Werke 1833, 52.

[4]G. T. Fechner, Ueber die subjectiven Nach- und Nebenbilder, *Pogg. Ann.*, 50, 1840, 445-70.

[5]J. E. Purkinje, Beobachtungen und Versuche zur Physiologie der Sinne, *Beit. zur Kennt. des Sehens in subj. Hins.*, 1819, 92.

[6]W. Scoresby, An Inquiry into Some of the Circumstances which Regulate the Production of Pictures on the Retina, with their Measure of Endurance, their Colors, and Changes, *Proc. Roy. Soc. Lond.*, 7, 1854, 117-22.

[7]M. Washburn, The Color Changes of the White Light After-Images, Central and Peripheral, *Psychol. Rev.*, 7, 1900, 39.

[8]W. McDougall, Some New Observations in Support of Young's Theory of Light and Color Vision, *Mind*, N. S. 10, 1901.

[9]Honmouth, Beiträge zur Kenntnis der Nachbilderscheinungen, *Arch. f. d. ges. Psychol.*, 26, 1913, 181-238.

[10]E. B. Titchener, Experimental Psychology, Instructor's Manual, Qualitative, 1901, 48.

[11]E. W. Brücke, Untersuchungen über subjective Farben, *Pogg. Ann.*, 84, 1851, 418-52.

[12]E. Seguin, Recherches sur les couleurs accidentelles, *Ann. de Chim. et de Phys.*, 41, 1854, 413-31.

[13]W. Berry, *op. cit.*, 334.

[14]*Op. cit.*, 330, 311.

[15]*Op. cit.*, 313.

Washburn, McDougall, and others are agreed that changes in the after-image accompany variations in the intensity and duration of the stimulus.[16] They do not agree upon the order of these changes. Our problem was to study the after-image and to analyze it with reference to specific alterations in the intensity and duration of the stimulus.

Experimental Procedure

Observers. Of the 11 persons who served as *Os* throughout the experiment, eight, Fr, Ma, Mc, Mo, Sc, St, and Tr, were undergraduate students taking courses in the advanced laboratory and with some training in introspection. Sh was a graduate assistant, and Ru and Ga were professors in the department. The writer acted as *E* throughout. With the exception of Ga, the eyes of all *Os* were in good condition. By means of lenses Ga had about one half normal vision.

The number of observations varied from 3 to 10 at one sitting, according to the duration of the fixation period and the intensity of the stimulus fixated. Seven hundred and fifty four observations were completed in the experiment, which lasted five months.

Apparatus. The experiments were conducted in a dark room, 2.8 by 5.6 m., which had no windows. All surfaces of the room and the furniture in it were painted black. The *Os* reported "total darkness" during the periods of adaptation and at all times when they were not exposed to stimulation. During the experiment *O* sat with her back to *E* and faced the stimulus, which could be raised or lowered to the level of *O*'s eyes. *E* sat at a table, 2.5 m. behind *O*, where she controlled the apparatus and recorded *O*'s reports. A large black screen, 1.2 by 1.5 m., was in front of *E*'s desk, to prevent *O* from seeing any reflection from the small desk-light.

A wooden box painted black and lined with white cardboard contained the stimulus-lamp. This box, which was placed on the shelf 1 m. in front of *O*, was 26.8 cm. high with a 14.7 cm. square base. A removable sheet of black cardboard, held in place by black thumb-tacks, with a Greek cross[17] cut out of it, formed the front covering of the box. The aperture was cut, not from the center of the cardboard sheet, but two-thirds of the distance to the top. The cross was 36 mm. in length and the width of the arms was 6 mm. An aperture of the same shape, though much wider, was discarded after a few trials during the preliminary procedure, because the edge of the cross did not appear "clear cut." One thickness of architect's paper was

[16] *Op. cit.*, 334.

[17] The particular form of the cross was the form known in heraldry as the "cross humetté or couped."

pasted across the back of the aperture. A black dot was drawn on the paper in the center of the cross as a point of fixation.

The box contained one of four "daylight" mazda bulbs rated at 25, 50, 75, and 100 w. The lamp-base was screwed to a flat piece of wood 1 cm. thick and small enough to slip easily into the floor of the box. It was necessary to attach the lamps to this movable piece in order that the smaller lights might be raised to keep the filament of the lamp directly behind the aperture which *O* fixated. Within the box there also was a 2 v. "flashlight" bulb which, when quickly flashed on and off by *E*, served as a 'Ready' signal to *O*. It indicated the approximate location of the stimulus in the dark room, and still it was too weak and too brief for after-image effects to arise. Three holes were bored in the top of the box for ventilation, and a small black tin shield, tacked around these, prevented any leakage of light. The wires connecting both the stimulus-light and the 'Ready' signal came through holes bored through the back of the box. These wires passed to switches on *E*'s table. A transformer provided current for both the 'Ready' signal and the table-light. This 2 v. table-light had a black shield around it to prevent reflection of light. A stop-watch was used to record temporal changes.

Conditions. All *O*s were able to fixate the dot without difficulty except Ga, who was requested to fixate the center of the cross. Several *O*s did not see the dot immediately when the 100 w. stimulus was exposed, but saw it under less intense stimuli. The fixation point became more distinct as the duration of the stimulus increased. The color changed somewhat with variations in intensity, from white to a slightly yellowish hue. Occasionally *O*s reported that the paper was granular when the stimulus was weakest (25 w.). For the most part the quality of the paper was not noticed. The *O*s were allowed to rest at intervals for varying periods of time if they reported that the stimulus was becoming painful.

We carefully avoided the inclusion of hypnagogic imagery in the flight of colors. Mo and St gave accounts of this subjective imagery which occasionally follows the after-images. The hypnagogic images were distinguished in that they were more vivid, much larger, and seemingly nearer the eyes than the other images. A vivid reddish purple was the color commonly experienced in this type of imagery.

Method. *E* read the following instructions to *O* during the 5-min. adaptation period before each experiment:

"At a given ready signal followed by the flash of light, you will steadily fixate the black spot on the Greek cross and continue to do so during exposure to the stimulus. As soon as the cross is illuminated, report all visual

changes noticed. After exposure, describe as fully as possible all visual effects and changes, including quality and form. Proceed from the center of image outward. Signal as soon as you experience any image."

A short preliminary series preceded the main experiments. The object of this series was to give the *O*s practice in describing the images, and *E* practice in technique. The preliminary series was begun with a 20 sec. exposure to a 50 w. stimulus. The duration was lengthened to 40 sec. as Ru and other *O*s believed a 20 sec. exposure too short a period on which to base the intensive series.

A. Intensive Series

The intensive series was begun with a stimulus of 50 w. and a duration of 40 sec. The 50 w. stimulus was used first because it was of medium intensity. After the adaptation period, in which the directions were given, *E* said "Ready," pressed the signal button, said "Now," and switched on the stimulus and started the stop-watch. At the end of 40 sec. *E* turned off the current and reset the stop-watch immediately to time the appearance of the image, the changes within it, and the length of the total image. *E* noted in a column at the left of the report the sec. at which each statement in the observations was given.

The following symbols were used for recording the colors: *R* = red, *B* = blue, *BK* = black, *G* = green, *g* = gray, *P* = purple, *PK* = pink, *Br* = bright, *Bn* = brown, *L* = lavender and *Li* = light. After each observation *O* reported other details which the rapid passage of the images had made it impossible to report at the time. This procedure was repeated several times during the observation hour. After each *O* had been stimulated 6 or more times by the 50 w. light, the intensity was changed to 75 w., and the experiment was carried on as before without change in the length of fixation. The lamp was then replaced by the 100 w. lamp and later by the 25 w. lamp. The duration of fixation for 40 sec. was retained throughout this series.

Although *E* noted that the *O*s usually described the images in the same terms, she had no exact means of ascertaining that they were all referring to the same qualities. And, on the contrary, although they sometimes described images in unlike terms, *i.e.*, bright *R* and bright cerise, they may have been experiencing the same quality. *E* therefore referred *O* to a chart of colors after every observation, and asked her to compare and contrast the colors in the image with those on the chart.[18] The chart consisted of 44 inch-squares of colored papers, numbered and arranged in a graduated series on a gray cardboard sheet 1 m. by 1 m., in the order of the hues around the base of the color

[18]The chart was made from the standard Milton Bradley papers.

prism. Upon seeing these colors *O* frequently mentioned characteristics of the images not noted before. For example, St said: "The color I saw was not a *R* like this one, but a luminous color, as if an electric light were shining behind a thin film of *R*." With practice the *O*s were able to remember the images until after they had seen the chart. This improvement in the procedure was of added importance, in that *O* attended to the images carefully in order to remember them as accurately as possible.

A method somewhat similar to that just described was used to determine if the sizes and shapes of the images were the same for different *O*s. Each *O* was asked to draw in outline the relative sizes and shapes of the images as compared with the sensation immediately after observing them. Usually *O* drew four or five figures representing the successive stages of the image. These drawings enabled *E* to know what *O* meant by "a pointed cross," "a diamond," or "a cross beginning to lose its ends," and were used to supplement and check all verbal reports.

B. Durational Series

The latter part of the experiment was devoted to the durational series. The 50 w. stimulus was exposed for 1 min. 30 sec., 60, 20, 10, and 5 sec. The 5 sec. interval was then repeated and the 10, 20, 60 sec. and 1 min. 30 sec. intervals, while the intensity of the stimulus remained fixed at 50 w. The results of the 40 sec. periods of stimulation were transferred from the intensive series to this. Had the longest fixation period been 1 min. 20 sec. rather than 1 min. 30 sec., the scheme of 20 sec. intervals would have been complete. The 1 min. 30 sec. period was first taken out of curiosity on the part of *E* to learn how *O* would react to it; and as the time for experimentation was limited, and several *O*s had already been exposed to the stimulus for this length of time, this period of stimulation was continued.

The *O*s were exposed to the 25, 50, 75, and 100 w. stimuli and were asked to report according to the directions first given. Because the *O*s could not keep in mind all the colors of the images resulting from the varying fixation periods, they were not required to compare the images with the colors on the chart, nor were they asked to draw the size and shape of the images, unless they were unusual. To make sure that the *O*s were correctly distinguishing one color from another they were given the Jennings "Color-Blindness Test." No *O* was found to be color blind.

Results

The results obtained from experimenting both with the intensive and with the durational series have been divided ac-

cording to the qualities of the images as indicated by the *O*s. These qualities reported with and without questioning by *E* are indicated by the following headings: (1) hue, tint, and chroma of image, (2) rise and subsequent temporal course of image, (3) fluctuations in image, (4) size and shape of image, (5) position of image, (6) rivalry and movement of color. The various observations have been considered with reference to the average reports both of the individual and of the group.

The usual and average time of appearance of the image after stimulation by the 25, 50, 75, and 100 w. was about 3 sec. after the removal of the stimulus, as is shown by the following chart.[19]

Stim.	*Number of Observations*	*First Appearance of the Image (Sec.)*			
		1	2–3	4–7	7–10
I	59	25	28	5	1
II	55	16	17	22	
III	60	8	36	15	1
IV	54	4	49	1	

As is indicated by the chart, a greater number of the images of I than of II, III, or IV appeared immediately. The more intense the stimulus, the less likely was the image to come as soon as the stimulus was removed. There is closer agreement concerning the moment of appearance of the image in IV than in I, II, or III. Seven of the 15 images that appeared after 3 sec. in III were Ga's. *O* occasionally experienced the image more than 3 sec. after the removal of one stimulus if she saw it occasionally 3 sec. after another stimulus had been removed. Five of the 11 *O*s always saw the image before 3 sec. after the disappearance of the stimulus, regardless of its intensity.

The average length of the images of I is 1 min. 10 sec.; of II, 2 min. 50 sec.; of III, 3 min. 35 sec; of IV, 3 min. 35 sec. The duration of the after-image of a relatively weak stimulus, *i.e.*, of I, differs from that of II by an amount twice as great as that by which the duration of II differs from that of IV, although the difference in the intensities of the former stimuli is but one-half that of the latter. The stimulus IV is 25 w. greater than III, moreover, although the average lengths of the images are about equal. The longest of the images of III and IV are but little longer than the longest of II, but II has many more "short-time" images. For instance, 14 images of II while only one of III and 3 of IV ended before 2 min. 15 sec. On the whole, the duration of the images of I and IV shows less variation than that of the images of II and III.

[19]The Roman numerals I, II, III, and IV are used to indicate respectively the stimuli of 25, 50, 75, and 100 w. Note that 40 sec. is the constant period of fixation throughout the intensive series.

The reports indicate that, if an *O* were subject to unusually long images after exposure to one stimulus, she was likewise subject to unusually long images following exposure to other stimuli.

Intensive Series

Hue, Tint, and Chroma of the Images

In the images resulting from I, *B* and *P* were the colors that appeared most often and were most sustained. *B* appeared in all observations except those of Ma and Mo; and *P* was experienced by all *O*s except three, Sc, St, and Mc. *G* or *YG* was observed by 4 *O*s, *Y* by 2, and *R* by one. These colors were seen with few alterations, as is shown by the fact that half the *O*s saw only *P* and *B* with no other changes. Four was the maximum number of colors experienced in any observation. All *O*s, with the exception of three, reported only one image without a halo or flare of any kind around it. These three *O*s described *B*, *G*, or *P* halos in the period between 7 and 25 sec. after the removal of the stimulus. Every *O* except St pointed to the same *B* color on the chart as being most like the *B* of the image. St pointed to the color nearest it. Although Ma was one of the 2 *O*s who did not report *B* in the image, she did, nevertheless, say that the *V* background was like the *B* color on the chart. The *P* and *BP* when imaged were usually reported as being like or near a *P* on the chart.

The following remarks are typical of those made concerning the tint and chroma of the image.

Fr "*P* cross, well saturated, gets darker gradually. Cross more saturated than background. *R* brilliant and fleeting."

Jo "Colors very bright at first, get darker. *B* in the cross darker and has more *P* in it than the *B* halo."

Ma "Colors dark and heavy. Do not change much."

Mc "Colors all darker and less saturated than in the images following more intense stimulation."

Mo "*G* well saturated. *BK* closes in upon dark *P*."

Sc "*B* a very dark color. Background becomes darker."

St "Background rather good. Colors in image *g*-ish."

Tr "Colors unsaturated. Cross gets darker. *B* very dark and poorly saturated."

In her various observations, *O* usually reported the same colors and the "shifts in colors," if there were any, at the same intervals.

The images following the fixation of II may be separated into definite periods in which particular hues predominate. *Y*, usually with one or more margins and halos, was the color most often imaged first. Thirty-three out of 60 observations had *Y* for the first after-image. Seventeen of the rest which began with *G* or *YG* changed to *Y* within a few sec. Consequently, in 50

out of 60 observations *Y* was reported as appearing immediately or almost immediately when the stimulus was removed. *B* appeared first in 3 images and *O* in 2. Halos were reported around the first image in all but 10 observations. Many times they appeared a sec. or two after the main image, and stayed about 20 sec. The usual *Y* image that appeared first was surrounded by a *R* margin within a light *G* halo. This *R* and *G* appeared in two-thirds of the observations. A dark *B* was reported many times between the *R* and the light *G* around the *Y* center. *BK*, *P*, and *L* were the colors experienced infrequently in the halos in place of the *R* and light *G*.

All but two *O*s reported that *R* took the place of the *Y* image. The *R* margin increased at the expense of the *Y*, until the *Y* became a mere spot within the *R* cross. Sc experienced no *R*, but continued to image *Y* with a border of dark *G* and either a *Li* or light *Y* halo. Ma, Mc, and Tr usually reported *Y* in the center of the *R* during this period. Other *O*s experienced no *Y* in the *R* image. A dark *B* or *G* border and a *Y* halo around the *R* image were often noted. Never were more than one border and one halo seen at a time.

Approximately 50 sec. after the image first appeared the *B* or *G* border had completely closed in upon the *R* which replaced the *Y* spot in the center. The images of Sc, Sh, and Ga became dark *G*, and those of Mo, *BK*. In the stage previous to this Mo had noted a *BK* outline around the *R* cross instead of a *B* or *G* one. This *BK* outline seemed to push the *R* into a spot just as the dark *B* and *G* outlines did in other *O*s' images. The other 7 *O*s reported that dark *B* replaced the *R* in the image. All *O*s described a light *G* or *Y* or a *YG* halo around the principal color, *B*, *G*, or *BK*.

The *R* completely disappeared, as the *Y* had done, from the center of the *B*, *G*, and *BK* images, and left the images still surrounded by the *G* or *Y* halos. At this time the *B* images which Tr experienced changed to *G*, and the *B* of Ma's images to *BK*, in several observations. This phenomenon did not occur with the corresponding disappearance of *R* in the observations of the other *O*s.

The image gradually darkened and often became *BK* before it disappeared. The images of Sc and Ga alone became light. Sc always reported a light spot, and Ga a light image at the end. Mc, Mo, and Tr visualized a small light halo around the dark color, but the remaining 6 *O*s experienced only the dark spot.

A few statements concerning the tint and chroma are here noted.

Fr "Colors more intense at first. *G* halo light. *R* gets darker. All colors darker at end. Colors of medium saturation."

Ma "First *G* cross light. Bright *R* cross gets darker and less saturated. *Y* cross bright and *B* dark."
Sc "First *Y* cross very bright. *G* crosses, except at last, of very dark tint."
Mo "*Y* halo very dull. Colors not very bright."
Tr "First cross pale *G*. Often *G* crosses very dark."
Sh and Ru "*R*, color a sort of cerise."
Ga "Colors unsaturated and faint. Dimmer than any on chart."

Summarizing these observations, we may say that the colors in the image became darker, the *B* and *G* crosses were always very dark, and the first *Y* cross was light, sometimes very bright and sometimes fairly well saturated.

A general trend in the images has already been noted. First there appeared a *Y* image with a *R* margin and sometimes a dark *B* or *G* halo around it. *R* gradually took the place of the *Y* and in turn gave way to dark *B* or *G* with a light *G* or *Y* halo around it. This image slowly darkened until it became *BK* or almost *BK* and disappeared.

Of the 74 observations of III, *Y* appeared first in 33, *G* in 25, *YG* in 11, and *P* in 5. The *G*, *YG*, and *P* images, with the exception of 3, all changed to *Y* within a few sec. These 3 observations began with a *GY* hue which did not change until it became *R*.

When the image of III appeared it had one or more halos, except in 16 observations; 5 of the 16 were Ga's, who saw no halos at any time during the images following this intensity; 5 commenced with a *P* spot, 4 with a *G* cross, and 2 with a *GY* cross. As soon as these images changed to *Y* they were invariably surrounded by halos. *R*, *G*, *B*, *P*, *BK*, and *OY* were the halos observed most frequently in the order given. Fr usually saw a *R* or *O* margin around *Y* and a *P* around that. Jo frequently experienced a *R* margin with a dark *B* or *G* background, Ma a *BK* border in a *P* background, Tr *R* and *B* borders and *G* halos, Sh *O* or *R* borders and *G* halos.

This first period of the image, in which *Y* predominates, varied in duration from 12 sec. to 2 min. The average length was about 50 sec.

The *R* image which took the place of the *Y* varied in the duration of time experienced. The average length is found between 3 sec. and 1 min. 3 sec. *R* followed *Y* in all images except in two of Jo's, one of Mo's, and all of Sc's and Ga's. (Note that Sc and Ga reported no *R* in the images of II.) Only in 15 of the 75 observations was *Y* imaged within *R*. Many *O*s reported that the *R* came upon *Y* very suddenly and not gradually, as it did in images of II.

The border around *R* varied from a dark *G* or *B* to *P* or an indistinguishable dark color. The *G* border was most frequently

noted, for it appeared in 26 of the images, the *B* in 14, and *BK* and *P* each in 11 images. These borders, which sometimes were so narrow that *O*s called them "margins," gradually increased and enveloped *R*. In all of the 75 observations, except those of Sc and Ga who saw no *R* in the image, *R* remained for a certain length of time in the center of the dark *B*, *G*, or *BK* image. A light halo of *Y*, *G*, or *YG* was always seen around the principal part of the image.

The *R* disappeared from 5 to 60 sec. after it was reduced to a spot in the center of the image. As it vanished, several times *O*s reported that the *B* image changed to *BG* or *G*. Only 3 *O*s, St, Mo, and Mc, noted no change in the *B*. *O*s who had seen *G* or *BK* and no *B* noted no change in it when *R* disappeared. Fr, contrary to other *O*s who seldom experienced *P* in the image, reported that it frequently alternated with *R* and *G*. *P* was the most constant color Fr saw during the last stage of the image. Six *O*s experienced a *BK* image in the last stage, 2 *G*, 1 *B*, and 1, Sc, "an indistinguishable light color." Eight *O*s reported "no halo" during the last stage of the image.

Generally speaking, the stages in the image were constant, and after one stage appeared the colors that had vanished did not reappear. In 14 of the observations of III *R* appeared occasionally to alternate with the *B*, *G*, or *BK* image.

Mo experienced *G* in the third stage of the images of III in place of the *BK* in those of II. The hues in both the central and peripheral regions of the image varied in small degree in the different observations of an *O*.

The following notations relating to the tint and chroma of images were made.

Fr "The *GY* hue first seen was the brightest color in the image. Colors most vivid during the first stages of the image. *Y* was very bright, *P* very dark."

Jo "*R* a luminous color. *G* border is dull and rather gaseous. This fuses into a darker color. The first *G* that came before the *Y* was light."

Ma "Bright *R* grows dark and less saturated. *B* is dark with a pale *G* background."

Mc "*Y* cross bright. First *B* of medium saturation. Dark *G* border and pale *Y* halos."

Sc "*G* background of *Y* cross became the *G* cross which is not so dim as the background. Images brighter than those of II. *G* predominates. Colors get dimmer and *G* darker toward latter part of the image."

St "*R* is a luminous color. *P* a vivid one. *B* grows darker."

Tr "*G* cross is quite dark."

20 of the 55 after-images of IV began with *G*, 8 with *Y*, 6 with an "unnamed light color," 6 with *YG*, 6 with *P*, 2 with *B*, and one with *R*. The two *B* images were seen by the same *O* and the *P* by two *O*s alone. The majority of the images began with *G* but very soon changed to *Y*. In 48 observations *Y*

appeared within 35 sec. from the beginning of the after-images. Ga, however, saw *Y* in only one observation. The colors she experienced were *P*, *PK*, and *G*. Half the *O*s saw no halo upon first appearance of the image. All *O*s, however, reported one or more halos within a few sec. after the image appeared, usually with the change from *G* or *P* to *Y*. In cases where *G* formed the principal part of the image, a *Y* border surrounded it and took its place. A *R* border with *B* and dark borders around it appeared around the *Y* cross. J, Mo, St, and Tr usually noticed more than one border around the *Y* image, *R*, *B* and *L*; *R* and *B*; or *BK* and *P*. Mo, Mc, St, and Tr were the *O*s who visualized one or more halos when the image first appeared.

In the images where *R* formed a border around the *Y*, the former color increased at the expense of the latter, as it did in the images of II and III. In other images *R* appeared suddenly in place of *Y* about 40 sec. after removal of the stimulus. *R* was present in all images except in those of Sc and Ga and in two of Ma's which were of unusually short duration, and remained continuously the principal color in the image for 30 sec. on the average. Only in the images of Fr did *R* alternate quickly with *Y* and *P*. When *R* appeared, *Y* vanished from the center of the images, except in those of Tr and Ma. Sc, who saw no *R* in the images, saw *Y* within the dark *G* cross after the *G* had partially taken its place. Fr usually experienced a *P* border around the *R* image, Mo a *BK* border, Mc, Sh, and Tr a dark *G* border, and Jo, Ma, St, and Ru a dark *B* border.

In turn, the dark *P* border in Fr's images changed into a *B* or *G* image alternating with *P*, the *BK* border Mo saw took the place of the *R*, the dark *G* border reported by Mc, Sh, and Tr formed a dark *G* image, and the *B* border of three images of Jo, Ma, St and Ru formed the dark *B* cross. The light *G* or *Y* halo that appeared around the *R* image occasionally surrounded the dark *B*, *G*, or *BK* image. Half the *O*s reported that this halo vanished about 1 min. before the rest of the image. All *O*s except Mc continued to observe a diminished *R* spot for about 60 sec. after the *R* commenced to give way to the increasing border of *G*, *B*, or *BK*.

This last stage, in which the *O*s saw only one color or one color in the surrounding light, was much longer than other stages in the image, for it lasted approximately 70 sec. *BK* was the last color seen by Mo, Sh, St, and Ga; *B* by Jo, Ma, and Mc; *P* by Fr; *Y* by Sc and Ru; and *G* by Tr. The *B* stage in these images was more sustained than the *G*, and conversely in III.

The following remarks concerning the color qualities of the images of IV are given to supplement the preceding section.

Fr "First *B* very bright. *P* dark but vivid. *G* cross fairly well saturated."

Jo "Colors become duller after the first appearance. First bright *R* grew very dark. *B* was always very dark. *G* halos pale and gaseous, and differ from surface colors on the chart."

Ma "First *Y* very bright and stays same. *R* very bright at first and fairly well saturated. Grows darker. Colors dull. *B* always dark. *G* halo pale."

Mc "Colors duller than those of III."

Mc "Colors not brilliant. First *Y* brightest. All colors below base of color pyramid."

Sc "*Y* image so bright at first that it burns. It fades. *G* very dark."

St "First *G* pretty bright. Other colors dull and unsaturated. Period of most saturation was a short time after they appeared."

Tr "*Y* cross the brightest color. *G* not so vivid as in images of III. More *BK* in image."

Ga "Colors not well saturated. All colors in image equally bright."

Ru "Best saturation in beginning of image. *Y* brightest of any color. *R* best saturated. There seems to be a reverse relationship between the image and its background; for when the principal part of the image is light, the background is dark, and *vice versa*."

It will be noted that all *O*s, with the exception of Fr, Sc, and Ru, described the images after the first period of time as being rather dull, dark, and unsaturated. The first *G* or *Y* seen was reported the brightest color by all *O*s, except by Fr and Ga who did not refer to it.

If we compare the colors in the after-images of one intensity with those of another we find that those of II, III, and IV may be roughly divided into periods, while those of I may not. The images of the latter are usually *B*, *P*, and occasionally *G*, with *R* and *Y* appearing in a few observations. A much larger proportion of the images of II began with *Y* than those of IV, whose after-images usually began with *G*. In II, III, and IV most of the images changed to *Y* within a few sec. after their appearance. The first images of IV had fewer halos than those of II and III. *R*, the color in all cases most often seen around *Y*, came in upon *Y* more gradually in II than in III, and it usually came very quickly in IV. Ma and Tr, the only *O*s who continued to see *Y* within the *R* cross in IV, were two of the *O*s, Ma, Mc, and Tr, who continued seeing it after exposure to II. In the images of III there are twice as many appearances of *G* borders as *B* borders around the *R* image. In IV the *B* outnumber the *G* borders. Many *O*s who saw a dark *B* image after the *R* in the flight of colors following one stimulus saw the dark *B* following other stimuli. Ma, Mc, and Jo usually reported *B*, Mo and St *BK*, Tr *G*, and Sc light *G* in the last stage of the image, regardless whether it proceeded from II, III, or IV. While only 3 *O*s experienced halos in the last stage of the image of II and III, 5 *O*s experienced them after IV.

In all observations the images were reported as having a tendency to grow darker, those of I as well as those of II, III, and IV. Many *O*s noted particularly that images of IV became very unsaturated after a relatively short period of time. This circumstance was not noted to such an extent by *O*s after less intense stimulation. The chart-references to the images of III and IV closely correspond, and in a measure we may conclude that the qualitative characteristics of images of III do not differ from those of IV.

Rise and Subsequent Temporal Course of the Images

The first appearance of the image following the various intensities of light was reported as quickly as possible to *E*. For instance, the average duration of Mc's images following I is 2 min. 40 sec., II 3 min. 30 sec., III 4 min. 30 sec., IV 5 min. 15 sec. Sc's images of I, II, III, IV likewise were of longer duration than the average *O*'s. St's observations, on the other hand, include comparatively short images following I, II, III, and IV.

From the reports concerning the rise and subsequent temporal course of the image we conclude that, generally, the more intense the stimulus, the more regularly did the images appear within 2 or 3 sec. after removal of the stimulus and the longer did they last. Increasing the stimulus from 75 to 100 w., however, shows corresponding slight change in the time of appearance and no change in the temporal course of the image.

Fluctuations in the After-Images

There were about the same number of fluctuations in the images of one *O* as in those of another. The number of fluctuations per image following I is 1.24, II 2.1, III 1.13, IV 1.55. The brevity of the images of I partially accounts for the relatively few fluctuations; therefore we may conclude that there are more fluctuations per min. after exposure to the less than to the more intense stimuli. The greatest number of fluctuations appeared in the latter part of the images. The majority of fluctuations in I came between 3 sec. and 1 min. 30 sec., in II 1 and 2 min.; in III 2 min. and 2 min. 30 sec., and in IV 2 min. and 2 min. 30 sec. We noted that the length of the images of III and IV was the same.

As there were many fluctuations during the latter stage of the image, there were few fluctuations in the early part of it. In the images of II, III, and IV the fewest fluctuations occurred during the first 30 sec., for there were only 6 fluctuations in the 185 images. In I, 14 fluctuations occurred during the first 30 sec. of the 59 images. Six of these, however, came after 20 sec.

We have so far been considering the disappearance and appearance of the whole image, not of one particular part of it. Following III and IV we find more changes within the image reported than in those following less intense stimulation. For instance after III and IV several *O*s, especially Fr, noted that *R* would go and come but "the dark around it would not disappear." We may assume, then, that many fluctuations of the whole image mean few internal changes.

There were very few fluctuations in the size and shape of the image. Seldom, if ever, was the image reported as changing back to a cross after it had shrunk to a diamond. When unusually shaped images were experienced, *e.g.*, the cross with several bars, they were reported as fluctuating.

Size and Shape of the After-Images

The general progression in the shape of the image was that from a cross, through a diamond, to a spot. This procedure was by no means constant; for in some observations the diamond stage was omitted, in others a spot or halo preceded the first imaged cross, and in a few cases no cross was seen in the image. After I the images of 8 *O*s commenced as a spot which stayed for several sec. before a cross appeared. Half the *O*s reported that the image vanished when it was still in the cross-stage, the others that after 30 sec. the cross disappeared in a spot.

Eight of the 11 *O*s reported a cross when the image following II first appeared. Ga's images, regardless of intensity of stimulation, all began with one or more spots in which the cross did not at first appear.[20] The other two *O*s, Ma and St, reported that the cross formed in the halo immediately. The cross-stage in II lasted about 2 min. usually, when 3 *O*s reported "just a spot" and the other 8 a "diamond." These *O*s saw the diamond-shaped image for 30 or 35 sec. when it vanished, leaving a spot in its place. In contrast to the usual appearance of the diamond-stage in II, which indicates a shrinking of the cross, no diamond was reported in any images of I, in which the cross seemed to vanish quickly into the halo.

After exposure to III, 3 *O*s said the cross formed 1 sec. after the halo appeared. Other *O*s reported the imaged cross first. All *O*s, except Jo and Ga, in whose images the cross did not shrink, reported the diamond in place of the cross at 2 min. 15 sec., or 2 min. 45 sec. All *O*s reported that the diamond disappeared in the spot or halo after it had been visible 30 sec. or more.

In IV 7 *O*s saw the halo before the cross. St alone imaged the cross throughout the flight of colors. Other *O*s' images

[20]Unless otherwise indicated, the shape of the imaged cross is the shape of the perceived stimulus.

changed from a cross to a diamond after 3 min. duration. The diamond-stage varied in length from 30 sec. to 1 min., when it vanished into a spot.

Summarizing the above reports on the shape of the image, we conclude that the cross is that most constantly experienced. All *O*s except Ga saw a cross during a part of each image. There is also a relation between the intensity of stimulation and the shape of the image. A halo appeared before the cross in many images of I and IV, but in few of II and III. The diamond-shaped image was absent in I, but usually present in II, III, and IV. The greater the intensity of stimulation, the longer did the image remain cross-shaped. In I the average length of time the cross was imaged is 30 sec., in II 2 min., in III 2 min. 30 sec., in IV 3 min. As color-changes have been found to take place more slowly in long observations than in short ones, so did changes in shape take place more slowly in images of long duration. Ga's images were different from those of other *O*s; for many times she did not see the cross at all, but only reported "spots." Several times, after she had seen the cross for a short time, not more than 30 sec., she declared that it suddenly tipped over like an "x."

In the images following I, all *O*s thought the cross to be of the same size as the perception except Tr, who reported it as three-fourths the perception and St, who sometimes reported it to be of the size of, and sometimes smaller than, the perception. The cross did not have time to alter in size before it vanished, and consequently remained constant in size. The halo around the imaged cross was described by some *O*s as being of the size of the halo around the perceived cross and by others as much larger at first; and it was invariably reported as growing smaller when the cross disappeared within it.

Eight *O*s thought the images of II were smaller than the perception and that they continued to get smaller. No mention of the size of the halos was made. The images of III were usually smaller or "a trifle smaller" than the perceived cross. Mc, Mo and St, however, thought that they were of the size of the perception at first. All *O*s except Sc described the image as "getting smaller before it disappears". In regard to IV, the image was usually reported as being one-half or two-thirds the size of the perception, and as diminishing in size as time went on. Sc and Ga, however, imaged the cross as of the size of the perception, and Mo described it as "fatter than the perception."

While most of the *O*s imaged the cross following I as of the same size as the perception and as remaining so, they reported that the after-images following other stimuli were smaller and became still smaller when they changed from the cross to the

diamond. The change in the size seems to be due to the change in shape of the image. We may conclude that the size of the image of II is the same as that of III and IV but smaller than that of I. These sizes may have been influenced by the supposed distances at which they were seen away from *O*.

Position of After-Images

The image was usually reported to be either at the same distance as the perceived cross or a little farther away. Several *O*s thought the image seemed to move away from them as it grew smaller. Others reported that it moved in a plane at a fixed distance from their eyes. This latter kind of movement, which was swifter and more constant than the former, was partially under the *O*s' control, who could change the position of the images if they brought their gaze back to a certain fixation. Six *O*s who referred to the distance of the image following I reported it to be that of the fixated cross. Only one reported it as nearer than the cross.

Ma "About the distance of perception. Hard to place."
Mo "Same distance as cross or perhaps a little farther away."
Sc "Same position as the cross. Spot gets farther away at the end when it becomes smaller."
St "Imaged cross a little further away than the perceived cross. Seems somewhat to the right of F."
Ga said the images of II were all further down and nearer to her nose than the perceived cross. Other *O*s reported the image to be in the same position as the cross except when it moved around.

Movement of the Images

The movement of the whole image up and down and from one side to another was dependent to a considerable degree upon the attention of *O*s, and because of this fact movement is not an important characteristic of the image.

The movement of colors within the image has been noted by other experimenters as progressing from the periphery toward the center.[21] In the images following I the colors did not seem to move in any direction. When other stimuli were used, *O*s very often reported that "the colors seemed to go in toward the center." This phenomenon was already indicated in this experiment when the hues of the after-image were discussed. In the greater number of observations the hues went in regular order from the edge into the center, where they grew so small that they disappeared. The colors early experienced in the image were reported as moving faster than those in the latter part of the image. During the first min. of the series, *O* found that she had hardly time enough to tell everything she saw.

[21]Berry, *Op. cit.*, 334.

Throbs and waves in the colors of the image were also noted. Tr and Ru especially described a sort of rhythm in the color when the image became dark *G* or *B*.

Tr "The cross is dark *G* with light *G* ends, short and pointed. There is a continual movement of the dark *G* into the light *G* and back again."

Durational Series

Hue, Tint, and Chroma of the Images

Altogether 212 observations of II were recorded with the 5 durations of exposure. As this number of observations is twice that obtained from I, III, and IV, we shall emphasize the durational experiments with II.

The colors of the images of II *a*[22] are similar to those of I which were discussed in the intensive series. *G*, *P*, *B*, and *Y* were the hues reported most frequently; *G* was reported by 4 *O*s and each of the other hues by 3 *O*s. *R* was not once imaged after II *a*. Gray was often observed as a background around the hue or as a late stage in the series imaged. Six *O*s reported *g*. St was the only *O* who did not experience color in the after-images following the II *a*. Only three *O*s, however, experienced more than one hue in a particular after-image. Except in those images where the hues became dark in tint or poor in saturation the image was observed as continuing unchanged to the end.

With the exception of St, all *O*s visualized two colors at some time in the after-image of II *b*. Ru, however, was the only *O* who experienced two colors at the same time; and if halos were reported they were always light or dark *g* with no coloration. We noted that St, who saw only one color in the images of *b*, saw no color in those of *a*. There is little agreement as to the hue itself. *G*, *R*, *P*, and *B* were experienced frequently. *R*, which was not experienced in II *a*, was always included in the images of II *b*, though at no fixed period. We found *R* usually in the middle stage of the images of II *c* and never at the end and seldom at the beginning. Many times *B* or *G* was experienced in the form of a margin or halo around *R*. And from II *c*, all except two *O*s reported one halo of definite hue, *P*, *G*, or *Y*, as being around the main part of the image during some period of time—usually the middle.

The images of II *d* have already been described in the intensive series. We found not only that *R* had a definite period of occurrence, but also that other primary hues, *Y*, *G*, and *B*, appeared at regular intervals. All *O*s except Ga and Jo saw *Y* or *YO* in the first stage of the image, *R* in the second, then *G* or *B* which became dark or black. *O*s reported one or two halos

[22]The symbols *a*, *b*, *c*, *d*, *e*, *f*, designate respectively the durations of exposure 5, 10, 20, 40, 60 sec. and 1 min. 30 sec.

in the beginning stage of the image, and more than half the *O*s experienced a light halo during the last period of the image. These halos and margins invariably were reported as going into the center, enveloping the main part of the image, and increasing until the center previously seen had disappeared. At the same time another margin took the place of the previous one. In the images of II *e*, *R* was experienced by all *O*s except Ga and St, *G* by all except Mo who saw *BK* in place of it, and *B* by all except 4 *O*s, Sc, Mo, Sh, and Tr. Gray was not present in these images. Although the periods of the colors were longer in *e* than in *d*, nevertheless the hues differed little. The main differences in the hues of *d* and *e* were these, *viz.*, following *e*, *G* was reported by 4 *O*s before *Y*, and after *d* only one *O* reported a *G* image before *Y*; and the last stage of the image of *e* was reported as having no halo, while the last stage of the image of *d* was usually described as surrounded by a halo.

The images of II *f* closely resemble these of II *d* and *e* in hue. *O*s who experienced *G* rather than *B* in the images of *e* did likewise in *f*. The stage in which *R* was the prominent hue was about 1 min. 30 sec. in both the images of *e* and in *f*. The last period of the image was 1 min. longer in *f* than in *e*.

Concerning the tint and chroma of the images just described, it has been noted that *g* was reported as being the most prominent quality following II *a*. As the duration of the stimulus was increased, the *g* was reported less frequently and after II *d* it was not reported at all. No hues in II *a* and few in *b* and *c* were reported as being saturated, and practically all the hues in the images of *c*, *d*, *e*, and *f* were well saturated; so we may conclude that, the longer the exposure to stimulation, the better saturated were the images following it.

The tint of the image did not change as much as the chroma when the duration of stimulation was altered. In all images some colors were light and some dark. All had the tendency to grow darker; *e. g.*, *R* which at first was well saturated and of medium tint became dark and poorly saturated, and *G* and *B* often were reported as dark and growing darker.

Mo "Colors very unsaturated and vague. I seem to be seeing it all through a thin gray veil." II *b*.

Jo "Pale background. Colors unsaturated. *B* is a pastel grayish color." II *b*.

If we contrast the hues of images of I *a* and IV *f*, the extremes in intensity and duration, the following facts emerge. Six of 10 *O*s saw no color at any time during the images of I *a*. The other 4 *O*s reported either light *Y* or *V* or dark *B* or *P*. The hues of the images of IV *f* appeared to be like those of IV *d* discussed in connection with the intensive series. The first

colors were very bright and light, and the others were reduced in brightness and lightness.

Rise and Subsequent Temporal Course of Images

After a 5 sec. exposure to any intensity of stimulus, a greater proportion of images appeared in 0.5 or 1 sec. than after any other length of exposure. These images, appearing as soon as the stimulus was removed, were always reported as "positive after-images." The "negative" images were observed as appearing at irregular intervals from 1 to 8 sec. after the "positive" had passed away. *Os* noted that, the longer the exposure to the stimulus, the less frequently did the positive after-images appear and the more regularly did the flight of colors arise within the first 4 sec.

There is a decided correlation between the duration of exposure to the stimulus and the duration of the image which follows it; for the longer the exposure, the longer was the image experienced. The exceptions to this general rule were the temporal courses of the images of *e* and *f* which differed but slightly from one another, although there was a difference of 30 sec. between the lengths of exposure. When we increased the intensity of stimulation from III to IV or the duration of exposure from *e* to *f* we found proportionally slight increases in the length of the after-image.

Fluctuations in the Images

Fluctuations were found to vary according to the duration of stimulation; for the fewest number occurred in the images of *a* and the most in those of *e* and *f*. As the images of *d*, *e*, and *f* are longer than those of *a*, *b*, and *c*, it follows that, the longer the image, the greater was the number of fluctuations. The shorter the fixation period, the earlier did the fluctuations appear. In *a*, *b*, and *c* there appeared one or more fluctuations before 10 sec.; and in *d*, *e*, and *f* no fluctuations took place in the image before 12 sec. Some *Os*, particularly Fr and Sh, always reported more changes in the images than others, some of whom seldom noted them, regardless of the duration or the intensity of stimulation.

Size and Shape of the Images

As a general rule we find that, the longer the stimulation, the greater was the proportion of cross-shaped images in the first period of the flight of colors and the longer did the images remain cross-shaped. Following longer durations of exposure, *i.e.*, *d*, *e*, and *f*, the images usually began in the shape of a cross, remained as such during the greater period of the image, shrank until they became diamond-shaped, and then became spot-shaped, and stayed so during the last few sec. of the image.

Following the 3 greatest intensities of stimulation, *i.e.*, II, III, and IV, the images changed from a cross to a diamond and then to a spot more abruptly in *d* than in *e* or *f* in which the change was gradual. No diamond-shaped stages were reported in the images of I or in *a* and *b* of II, III, and IV, and few in *c*.

The imaged cross was usually reported as smaller than the perceived cross regardless of the length of exposure to stimulation. Seldom did the images from II *a*, II *b*, and II *c* diminish in size during their course, while the large proportion of those of II *d*, II *e*, and II *f* grew smaller during the latter stages. These facts indicate that the image became smaller as it changed its shape, but that it did not usually become smaller, *e.g.*, in *a*, *b*, and *c*, when the image remained a cross throughout its course. Likewise following I *e* and *f* the majority of *O*s thought that the imaged cross did not noticeably alter in size.

Position of the Images

The position of the image relative to *O* and to the stimulus has not been adequately determined for two reasons. Too few *O*s described the position of the image; and some of those that did describe it thought that it did not seem to have an exact location. The varying durations of stimulation had no effect upon the position of the image; for it was usually noted as being at the same distance as the perception, when its position was noted at all.

Movement

The colors in the images following short periods of exposure did not move in any direction. As the exposure increased, movement was reported usually as taking place from the periphery to the center of the image. The only statements of *O*s that indicate any movement in the opposite direction are those concerning the disappearance of the image, when "the image became diffused and faded into the background."

The *O*s did not stress the movement of the whole image after any exposure. Only one movement was reported in all the images of II *a*, one in II *b*, none in II *c*, and 4 or 5 in all the images of *d*, *e*, and *f*. *O* believed that this movement of the image which occurred occasionally was dependent on her own eye-movements rather than due to the effects of stimulation.

Summary and Conclusion

An examination of the various characteristics of the image, as noted in the results of the intensive and durational series, has proved them comparable in many respects.

Fewer hues of poor chroma and of darker tint were reported in images following the shortest exposure to any intensity than

in those following medium exposure to the least intense stimuli. *R*, which was absent in the images of I and *a*, was observed in other images by all except 2 *O*s, and was more regular in its rise and fall than either *P* or *B* of the preceding weakest and shortest exposures. The images following longest exposure to I and those of medium duration of II, III, and IV, were divided into periods of *Y*, *R*, *B*, *G*, and sometimes *BK*. With longer exposures or more intense stimuli, a *G* or *YG* stage preceded the first *Y* stage, but gave way to it in a few sec. The stages of color became longer with the increased duration of exposure, and the *R*-stage became longer proportionally than did the other color periods.

After the intensity equalled III or the duration *d*, the hues, tints, and chroma of the image did not alter with increases in intensity or duration of stimulation.

The after-image usually appeared about 3 sec. after the removal of the stimulus, but it varied both with the intensity and duration of the stimulus. Positive after-images appeared frequently after brief exposures; but the images which followed them were correspondingly irregular in their appearance. The images following longer exposures came regularly but not immediately.

There is considerable consistency in the reports of an individual *O*. If her images were longer than those of the average *O* following a certain intensity and duration, they usually were longer following other intensities and durations. In the observations of all *O*s long images followed both long and intense stimulations. When the intensity of stimulation, however, was increased from III to IV or from *e* to *f*, the maximum intensities and durations used, the increase in the lengths of images was proportionally small. The size and shape of the image likewise varied according to different exposures. The diamond-stage was not present in the images of I, and in those of *a* and *b*. The longer or the more intense the stimulus became, the more gradual was the change from the cross through the diamond to the spot. The image became progressively smaller as the shape changed. In the images of I and in those of *a*, *b*, and *c*, there was no decrease in the size of the cross, just as there was no change in the shape of it.

The longer the stimulation, the greater was the number of fluctuations in an image, but a few *O*s experienced many fluctuations in the image regardless of the intensity or duration of the stimulus. In the images of *a* and in those of I, the fluctuations appeared earlier than in those of *b*, *c*, *d*, *e*, *f*, or II, III, IV. The greater number of fluctuations appeared in the latter stages of the image.

Neither the intensity of the stimulus nor the duration of fixation affected the position of the image. The position was reported as at about the same distance as the stimulus, but often it did not seem to have any particular location.

In the images resulting from short exposure there was no movement of the colors from the periphery to the center. A continuous movement to the center occurred when the duration and intensity of the stimulus were increased to *d* and to II. As the intensity and duration increased, the more rapidly did *R* surround *Y*. The colors following *R* did not advance with such rapidity.

The movement of the whole image was considered as of minor importance. Sometimes, when the image suddenly became smaller, it was reported as farther away.

In general, our results seem to verify the statements of Titchener and Washburn that the images of practised *O*s show fairly close agreement in the characteristics of the image. For the most part there is agreement among *O*s concerning all the factors we have described: the hue, tint, and chroma of the image; its rise and subsequent temporal course; its size and shape; and its fluctuations.

(1) The hues of the images following weakest and shortest stimulations, *i.e.*, 25 w., and 5, 10, and 20 sec., are usually *B* and *P* and occasionally *G*, while those following other stimulations are *Y*, *R*, *B*, and *G*, in spectral order, with the infrequent additions of *P*, *O*, and *BK*. All images have a tendency to grow darker and less saturated before they disappear.

(2) After exposures of slight intensity and brief duration, *i.e.*, 25 w., and 5, 10, and 20 sec., the images usually take their rise the sec. after removal of the stimulus, while after other exposures the images very often appear 3 sec. after exposure. The subsequent temporal course varies with the intensity and duration of stimulation. The average length of the images of 25 w. is 1 min. 10 sec., 50 w., 2 min. 50 sec., 75 w., 3 mi. 35 sec., and 100 w., 3 min. 35 sec. By increasing the stimulus from 75 to 100 w., or the duration of exposure from 60 sec. to 1 min. 30 sec., we find no corresponding increase in the length of the images.

(3) The images usually begin in the shape of a cross, remain as such during the greater part of their course, shrink until they become diamond-shaped, then shrink to a spot and finally disappear. The diamond-shaped stage is usually omitted after brief exposures and those of weak intensity.

(4) As a rule, the imaged cross appears to be of the size of, or a little smaller than, the perceived cross.

(5) The period of fluctuation occurs in the latter part of the image; and usually, the longer the duration of the image, the later does it occur.

(6) Movement and position play an unimportant part in the flight of colors.

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PSYCHO-ANAESTHESIA

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I.

By psycho-anaesthesia is here meant the philosophic tendency to ignore other people while admitting their distinction from oneself. Since this distinction concerns different minds, the term approximately follows the pattern of the compounds "*color-blindness*" and "*tone-deafness*." Like the words "color" and "tone" the prefix "psycho" names both the things reduced to one—in the present instance inconsistently.

The memory of anything involves a belief in the past occurrence of an event not happening at present, that is, in motion from future to past. If the verification of a belief is taken to consist in seeking the happening of what is believed in, this belief is unverifiable, since the past cannot happen again.

There is a like belief in the present occurrence of events not at present actually happening. This belief is likewise unverifiable, since the present becomes the past when its actual happening is sought. Of these events it may be believed that some are actually happening in a new sense, differing *toto caelo* from the first. In this new sense actual happening is plural. Events may be actual occurrences for, at, to, or in one unit, and not for, at, to, or in some other. Events that actually happen in the first sense together make up one of the units of actual happening in the second sense. This unit is called "oneself," or "I," the remaining units of the plurality believed in being "other people" or "others;" and both together being called "we." Events believed to happen though not actual in the first sense may be called "assumed" events, and the word "actual" restricted accordingly.

It would appear a logical solecism to conceive that the ultimate source of the belief in "others" is an analogy drawn between one's own body and another like it. The argument may be analyzed as follows. In the midst of the mass of events actual at any moment a group may occur which more or less resembles another more persistent group called my body. This first group, or like living body, taken together with other events actual at the moment (*e.g.*, a blow on the other body) brings up a memory of my body in a similar situation, with memories of certain accompanying events (*e.g.*, a sensation of touch or pain). With such accompanying events the resemblance be-

tween the memory and the events that excite it ceases. Only the memory is actual. Nothing like it occurs, and if anything more is to be believed in, it must be assumed. Such an assumption is that of events in another unit of happening, a unique conception which proves nevertheless compatible with a likeness between the events assumed and the events remembered. This likeness analogy teaches, basing itself upon the conception of "others" which it is asserted to create. The supposed argument from analogy is one of the many disguises worn by *petitio principii*.[1]

The doctrine in which the assumption is not made is called Solipsism. Unless the conception of self is not a part of the conception of plurality of happening this term would appear internally contradictory. It means in this case that all events belong to a single self, the conception of which involves that of other units of happening, that is, does not include all events. Whether the doctrine itself is internally inconsistent is a different question.

Assuming plurality of happening, such terms as "I," "others," "we" and "person" or "people" receive unequivocal meanings. "I" is all actual events, or events occurring in the unit "me;" "others" are all events assumed to occur in certain other units, or "persons" believed in; "we" the sum of both. For convenience, an event occurring in a certain unit may be spoken of as

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[1]The Editor has kindly referred the writer to Th. Lipps' *Leitfaden der Psychologie* (1906, 34f.) for another refutation of the analogical argument and for a brief statement of Lipps' theory of the origin of the belief in "others" through Empathy or Self-objectivation. Lipps writes: "What self-objectivation means is this: It happens through an ultimate instinct that in grasping by the senses certain processes and events . . . a vital activity, feeling, volition, or other, awakens in the percipient so strongly as to make a single conscious experience with the act of perception. In that case, although it arises in the percipient, it becomes for his consciousness bound up with the object perceived, that is, resides, or is objectified in it . . . In short, other persons are the result of a multiplication of myself." To this doctrine it may be replied that no process whatever, objectivation or other, applied to the self would make another self out of it; no multiplication of a thing would make the multiples stand alone. Yet "others" do in fact stand alone to our belief, and inexplicably as Lipps observes: "It should be added, as a fact of this objectivation, that objectified experiences and unities of them, in becoming objectified, present themselves, again in inexplicable fashion, as something independent of the consciousness, that is, as something that would exist even when I had no consciousness of it." To the writer this empathic account of our belief in "others" seems but a still further disguise worn by that arch-deceiver, *petitio principii*. It is true that, in a field like this, the power of language to conceal thought, both one's own and others', shows at its best, and disagreement is to be expressed with all reserve.

an event "experienced" by that "person", or happening in "his experience."

Accepting these terms with these meanings, I may believe of a given event that it might happen in the experience of given people and no others. Or, more explicitly, since no individual event recurs, that examples of a given class of events might so happen. Or, I may believe of a given generic event in the experience of a given person that it could not happen in the experience of any other.

Events may accordingly be grouped into classes containing such as can happen in this or that person's experience only, or in the experience of a given selection of persons only, or in the experience of all the people believed in.

People may in turn be grouped into classes containing all the persons who can have experiences of a certain kind. These classes of persons may include, exclude or intersect one another in various ways. If any person can have experiences that no one else can have, that person alone will constitute one of the classes. If any experiences are such as can be shared by all the persons believed in, there will be one class including all persons. Classes containing more than one person may be spoken of as "pluralities."

Still another belief about present happening is possible; namely, that events may be happening without happening in the experience of any one. Like the belief in "others" this belief is unverifiable; but it has a logical standing inferior to that of the belief in "others" in that this belief needs no explanation, while it is difficult to say what is meant by events happening without being experienced by any one.

For example, if it is claimed that the phrase means *events happening without being perceived* it may be argued in reply that these include all events. An event remembered *is* not a part of me as the memory of it is a part of me. Nevertheless I believe it *was* a part of me. Likewise an event perceived may not *be* a part of me as the perception of it *is* a part of me. But unless, against Occam's warning, entities are multiplied beyond necessity, its alien character is the same. It *was* a part of me as the perception of it *is*. Perception, by this reasoning, becomes a case of memory like reflection. *Percipi* is *fuisse*. In so far as an event is perceived it is no longer happening. Accordingly, all events that happen at all happen without being perceived.

Another sense of the phrase *events happening without being experienced by any one* is expressed in a conditional proposition. To say that the other side of the moon happens though no one may experience it means that were conditions other than they are, some one would. But in this sense the phrase does not

mean that events *are* happening without happening in any one's experience, but that events *might* happen in some one's experience.

It would thus appear that a meaning other than either of these two may reasonably be demanded for the difficult phrase. Yet, notwithstanding its difficulty, let the phrase here be used in deference to much philosophical opinion. It will be understood that the phrase means only events which, though they do not at a given time occur in anyone's experience, might at some time occur in some one's experience. Events that could not so occur concern none of us, and are not matter for any discussion between us.

Events may then be happening at any time not only in one's own experience but in that of others, or without being experienced at all. This belief may take either of three forms. All of the events, or none of them, may be such as can happen in pluralities; or some events can happen in pluralities and some in one or other person's experience only. An event may be spoken of as forming part of an outer or an inner world according as it can happen in a plurality or in one person's experience only.

Accepting the first of the three alternative beliefs—that all events can happen in a plurality—there exist, in the sense of happening, no inner worlds. What exists, or happens, is one or more outer worlds. Accepting the second alternative—that no events can happen in any plurality—there exist no outer worlds. What exists is the inner worlds of the persons believed in. Accepting the third alternative—that some events can happen in pluralities and some in one or another person's experience only—there exists at least one outer world, and possibly as many inner worlds as there are persons.

The term mind may be attached in two ways to these conceptions of outer and inner. Every event which can happen in any one's experience may be called mind; or only such as can occur in the experience of one person only.

Taking the wider definition of mind, since every event can happen in some one's experience, mind will include all events. Accepting with it the first alternative belief above stated—that all events are such as can happen in a plurality—all events belong to an outer world as well. Accepting instead the second alternative belief—that every event happens in the experience of one person only—there is no such thing as an outer world. Accepting in turn the third belief—that some events can happen in a plurality and some in one or another person's experience only—outer events and mind interpenetrate; all events are mind and some belong also to an outer world.

Restricting the notion of mind to events which can happen in the experience of one person only; and accepting the first alternative belief, there is no such thing as mind. Accepting instead the second alternative, nothing but minds exist. Accepting in turn the third, outer events and mind together include all events but without interpenetration. They happen side by side, in each unit, or self; or apart from any.

Taking up the most complex of these positions; that is, accepting provisionally the belief that although there are for purposes of discussion no events that *cannot* be experienced by any one, there are events that *are* not experienced by any one; further, taking the definition of mind which restricts it to inner worlds; and finally, accepting the third of the alternative beliefs, according to which some events can happen in pluralities, and some can be experienced by one or another person only; the events of any moment divide themselves for my belief into six mutually exclusive categories.

I. Events actually happening that can happen in a plurality; or outer events of mine.

II. Events actually happening that can be experienced by myself only; or mental events of mine.

III. Events assumed to be experienced by another person that can happen in a plurality; or outer events of that other.

IV. Events assumed to be experienced by another person that can be experienced by him only; or mental events of that other.

V. Events assumed to happen without being experienced by any one, that can happen in a plurality. These might be called "unseen" events of outer worlds. "Unseen" in this use would not have the same meaning as "unperceived."

VI. Events assumed to happen without being experienced by any one, that can be experienced by one person only; or "unseen" mental events of myself or some other or others.

The items of Categories I, III and V—events actually experienced at some moment, or assumed to be experienced by some one or by no one at that moment, that can happen in a plurality—make up the outer worlds of that moment.

The items of Category II—events actually happening at some moment that can be experienced by myself only—make up my inner world or mind at that moment.

The items of Category IV—events assumed to happen at some moment in another's experience that can be experienced by him only—make up the inner world or mind of that person at that moment.

The items of Category VI—events assumed to happen in no one's experience at that moment, that can be experienced by one or another person only—make up the unseen worlds, or minds, of those persons, myself or others, at that moment.

Psycho-anaesthesia, or the philosophic tendency to ignore other people while admitting their distinction from oneself, will

here be interpreted as consisting in confusions and oversights having to do with the first four of these categories.

II.

The saying attributed to the French physician Cabanis—"The brain secretes thought as the liver secretes bile"[2]—is a classical expression of psycho-anaesthesia. The saying affirms an analogy between two pairs of terms; one, a brain and its thoughts, separated in fancy by the unique distinction between an actual outer event and an assumed mental event, events respectively of Category I and Category IV; the other, the liver and the bile, both in fancy actual outer events, belonging to Category I. When the distinction is recognized, the analogy falls to the ground. If it is overloked, other units of happening are ignored.

The standpoint of B. Russell's recent "Analysis of Mind" is apparently likewise that of psycho-anaesthesia. Like Cabanis, Russell considers two pairs of terms, on the one hand a table and its aspect to a supposed observer, on the other a star and its effect upon a photographic plate. Russell offers the second illustration in place of the first, in order, as he writes (p. 99), to eliminate "an irrelevant psychological suggestion" introduced in the first by the reference to our perceptions. Here again, the members of one pair, the table and its aspect to a supposed observer, are separated in fancy by the unique distinction between an actual event and an assumed event, both in this instance being outer events, that is, belonging to Category I and Category III respectively. The members of the other pair again both belong in fancy to Category I. As before, when the distinction is recognized between the two Categories involved, in this instance I and III, this analogy too falls to the ground. If it is overlooked, "others" are ignored.

The question remains whether Russell's analogy still holds in respect to the positions of the pairs of events. These are visual events. What is called the "position" of any one is the complex of relations of the special kind called spatial which a visual event bears to the rest of the visual manifold of which it

[2]E. B. Titchener has pointed out in this JOURNAL (25, 1914, note 64 to p. 443) that the comparison of the liver and the brain is unjustly attributed to Cabanis. It appears half a century earlier (1775) as a caricature of materialistic doctrine in a letter addressed by Frederick the Great to Voltaire. Yet Cabanis' own language at least comports with the psycho-anaesthetic fallacy, as Titchener makes clear in quoting Cabanis' reference to "la secrétion de la pensée" by the brain. Secretion is a process by which something appears in connection with an organ; but thought does not appear in connection with the brain. It has to be inferred from brain activity. As Titchener remarks, something very different from secretion takes place here.

is a part. The aspect of the table has its assumed position in this sense as the table itself, the star and its effect upon the photographic plate have each its actual position. Is this assumed position of the aspect the head of the observer, just as the actual place of the effect of the star is the photographic plate; or does the analogy break down here also?

This question can be decided only by a reference to the source of the analogical argument made possible by the assumption of plural happening. This source is my visual memory.

Most of the elements of my visual manifold may change from moment to moment; but certain scanty and vague elements, spoken of as belonging to my head, are relatively constant as long as any visual manifold at all is actual—except in the form of a blank, as in closing the eyes. The visual manifold apart from, that is spatially elsewhere than, my head may change within limits throughout. The complex of space-relations of my head to the rest of the visual manifold may be called a "point of view." Although the manifold may change with the exceptions noted, there may still be a similarity between certain of the new elements and certain of the previous elements. If the similarity is considerable, the pairs are spoken of as different "aspects" of the same "things." If the space-relations of my head to the new aspects of any two things differ from its space-relations to their previous aspects, the space-relations of these to one another meanwhile remaining the same, my head is spoken of as having moved into a new point of view with respect to these things.

The conception of a supposed observer of a given table presents such a memory of my head moved into a new point of view. Any new aspect of the thing I call a table retains in this memory the space relations it actually has to any other given thing apart from my head. The assumed aspect has in a word the position of the actual aspect. It does not occur in the head of the supposed observer, as the image of the star occurs on the photographic plate, but in the actual position of the table. Russell's analogy appears to break down in the matter of position also.

In a detailed discussion of this matter ("Our Knowledge of the External World", pp. 90 ff.) Russell reaches a definition of the position of anything in space by conceiving a series of appearances of the thing from different points of view arranged according to the size of the appearances. This series, Russell notes, has a practical limit in that a thing cannot appear larger to us than it does when in contact with the eye. Yet it is evident that the series may be theoretically prolonged by conceiving the equivalent of the entrance of the thing into the eye or head. One of the visual manifolds or "perspectives" obtained

by such a theoretical prolongation of the series of appearances of the thing Russell regards as the position of the thing. This statement is equivalent to defining the position of anything in space as approximately the position which the head of the percipient would occupy were it to approach so near the thing that the thing would no longer be visible. This is obvious. On the other hand, it is not equivalent to saying that the appearance of anything to a percipient is inside his head. This is absurd; since his head is in part also an appearance to him and in a different position from any other. Is not this absurdity, nevertheless, what is asserted in saying, as Russell does (p. 92), that our private visual world—the sum of things we see—is in a sense inside our head?

By means of this argument Russell speaks of the aspect of a given table to a supposed observer as occurring at a "passive" place, as an effect produced in the observer's head by the table which itself occupies an "active" place; the relation between the two being that of the effect of the star on the photographic plate to the star itself, these occupying respectively other "passive" and "active" places. How can this assignment of the aspect to a "passive" place be given a rational meaning?

Though the aspect of a visual thing to me is plainly not in my head, I may, at least in a fashion, locate my assumption of such an aspect to a supposed observer, in his head; and in common speech do so locate his mental operations. Thus the thought or absence of thought of another is popularly located in his "long" or "empty" head. If then my assumption of an aspect of a visual thing to another—my thought or fancy of it—be mistaken in reflection for the aspect itself—for the appearance thought or fancied,— as the memory of an event may be mistaken in reflection for the event itself, the analogy holds. Such a confusion is an instance of a subtler psycho-anaesthesia in which Category II is confused with Category III; a mental event consisting in my thought or fancy of the aspect of the table to a supposed observer is confused with an outer event consisting in that aspect itself.

This subtler psycho-anaesthesia continues to ignore "others." They remain in so far a name for our thoughts of them. To such an unequal standing they appear assigned in Russell's broad differentiation between physics and psychology. "Broadly speaking", he writes ("The Analysis of Mind", p. 307), "physics groups particulars by their active places, psychology by their passive places." For if it is not the aspects of visual things to "others" but only my thoughts of these aspects that can be conceived to have passive places at all, this psychology in so far robs "others" of any distinction from oneself. Russell ex-

presses elsewhere ("Mysticism and Logic", p. 157) the great satisfaction it would give him to do this; but in the "Analysis" proposes (p. 133) to "continue yielding to the prejudice" that "things exist outside my own biography." These assumed events in the biography of others Russell nevertheless reasons about as if they were actual events in his own.

Another psychology, that of Behaviorism, appears to fall short of giving full recognition to the first four categories, in part by a denial of fact, in part by a restriction of method. The events of Category II, that is, of my mind, are resolved by Behaviorism into "implicit behavior"[3] ("thinking" is chiefly sub-vocal talking), events of Category I; and in consequence the events of Category IV into those of Category III. These latter are then omitted as objects of study altogether, the doctrine explicitly restricting the field of psychological inquiry to conduct, animal or human, that is, to happenings in living bodies, events of Category I.[4] "Others" become for Behaviorism their conduct, which is part of my outer world. Nevertheless, Behaviorism apparently recognizes that events of Category III may happen. But since any that do happen fall outside the limits of experimental investigation, they are excluded on principle. Behaviorism thus appears to involve a type of psycho-anaesthesia that in part denies and in part ignores the existence of other people as distinguished from oneself.

These are two currents in a tide of psycho-anaesthesia otherwise astir in the pragmatistic and realistic philosophies of the past and present generations.

Pragmatism, strictly interpreted as the doctrine that all and only such propositions as are verifiable are true, implies a denial of the distinction between others and oneself. The proposition, There are various units of happening, is unverifiable, therefore untrue. Or, if Pragmatism be considered a doctrine of the meaning of propositions, to the effect that no proposition neither verifiable nor falsifiable has any meaning, the assertion of plural happening, according to the strict pragmatist, has no meaning. It is not its assailant, so the strict pragmatist might contend, who is afflicted with psycho-anaesthesia,—seeing but one thing where there are more than one,—but its upholder who is afflicted with psycho-strabismus,—seeing more than one thing where there is but one. Such an opinion can certainly not be adhered to; and that it was ever entertained is symptomatic of psycho-anaesthesia.

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[3] J. B. Watson, *Behaviorism: an Introduction to Comparative Psychology*, 1914, 19.

[4] *Ibid.*, 1.

The tenet stated first in the platforms of the New Realists is the doctrine that "things known may continue to exist unaltered when not known."[5] Critical Realism, as its name imports, materially modifies this doctrine without abandoning it.[6] In these philosophies the conception here interpreted as that of happening without happening in any unit becomes of foremost concern. Categories V and VI, which together represent it in the present essay, accordingly take precedence over those based on the distinction between other people and oneself. The centre of gravity of philosophic thought moves away from the distinction while still feeling its influence. A sense little used is apt to atrophy; and this would be the fate of the philosopher's sense of personality, were the balance not righted in his further inquiry. The New Realist admits that his doctrine must at first take the form of a protest. "It is perhaps unavoidable, that the new realism must for a time remain polemical in tone."[7] In fact the doctrine itself is a polemic, protestant and not catholic in nature. In so far as a defense of something unrecognized, it demands to be completed by a statement of what there is to recognize. Things sometimes known and sometimes unknown, with any data that constitute the knowledge of them, are not all that may be believed in. Various units of knowing may also be believed in. To apply again the term of the present essay, it would appear that, while realistic doctrine is not the product of psycho-anaesthesia, the realistic mood has an inherent tendency to produce it.

But the tide of psycho-anaesthesia now flowing in philosophy has its chief source without doubt in the imposing modern growth of experimental science. Experiment is verification. Plural happening is unverifiable. Hence either my belief in "others" must be abandoned, or it must be admitted that experimental science has not everything that happens for its province. It is not surprising that at a moment when the word "unscientific" is a term of reproach, an adjective for the nugatory and that which merits no attention, the philosophic belief in other people should waver and suffer eclipse. The psycho-anaesthesia of the present scientific age is like the visual anaesthesia engendered by a brilliant light that for the time obscures other things which nevertheless are there.

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[5] E. B. Holt and others, *The New Realism; Coöperative Studies in Philosophy*, 1912, 474.

[6] D. Drake and others, *Essays in Critical Realism; a Coöperative Study of the Problem of Knowledge*, 1920, 102. "Now it is true that critical realism shares with Locke the doctrine that one's data and the things themselves—such as physical objects and other people's experiences—are not identical."

[7] *The New Realism*, 1.

A CASE OF ACHROMASIA WITH COMPLICATIONS

By H. R. Crosland, University of Oregon

It is not frequent, in elementary psychology classes, that one runs upon persons of an unusual type or upon cases deviating greatly from the normal and expected. Especially is this condition true in respect to the matter of color-vision. But the case to be described in this paper happens to be unusual; and the facts concerning it will possibly be of interest and value to persons other than the author; we shall present them for whatever worth they may contain.

Mr. X is a student, about twenty years of age. In ordinary contact with him, one observes that he wears glasses and that these have uncommonly thick lenses. One observes also that, even with glasses, he places ordinary printed matter nearer the eyes than does the normal person in a similar act of reading. If one is still observant of X, one discovers that his eyes are diverged from the usual parallel position, the right turning temporally and downward, and that the left eye bulges somewhat from its socket. Such, then, is the *S* upon whom several tests have been directed; and many of these tests have been in the nature of exploratory or side-issue tests to enable, if possible, a better understanding of his defective color-vision. These collateral tests have exhibited complications which accompany the *S*'s inability to discriminate between hues or chromas. We shall present the facts of his color-blindness first, and then later we shall take a glance at the complicating conditions.

The large set of Holmgren skeins was used in the experiment to test the *S*'s color-blindness. The full set (*minus* those skeins whose numbers are lacking from Table I) was placed on a large grey cardboard on the top of a table. The *S* was comfortably seated at the table, which was in the center of a room uniformly lighted by early afternoon spring sunlight through 6 windows at his right. He removed his glasses. No color being mentioned to him, he was told to sort into a pile all skeins which seemed alike in color or hue if he could do so (of course the word 'hue' was meaningless to him, as will be apparent presently). He was allowed all the time he desired; also he was wholly free to move the skeins as near his eyes as he cared to do. Under such conditions, there resulted from his sortings, discriminations, re-sortings, etc., the following groupings (Table I), each containing those skeins which 'looked alike' to him.

TABLE I

Assortment I
dark green (poorly saturated) (15)
dark (blue) green (59)
dark green (with slight trace of yellow) (13)
dark, dull blue (74)
medium rose (blue evident) (21)
very light pink (27)
red orange (37)
(brownish) red orange (39)
light bluish green (77)
brownish yellow (S)
dark green (45)
medium violet (90)
medium reddish brown (12)
dark green (slight trace of yellow) (67)

Assortment II
standard red (31)
deep, brownish red (95)
very dark red (35)
dark red (29)

Assortment III
very light yellow (almost white) (R)

Assortment IV
light yellow (Z)
very light pink (81)
very light blue (26)

Assortment V
dark, yellowish brown (34)
deep violet (92)
reddish brown (N)
very dark green (slight trace of yellow) (69)
very dark green (19)
dark blue green (55)
very dark green (53)
very dark (blue) green (51)
dark yellow brown (36)
medium rose (near red) (33)
dark blue (trace of violet) (78)
tannish brown (D)
reddish rose (89)
medium tan brown (A)
light rose (75)

Assortment VI
red yellow (U)
light blue (72)
yellow (trace or orange) (Y)
yellow green (43)
medium green (slight trace of yellow) (97)
yellow tan (64)

Assortment VII
very light violet (80)
light pink (71)
light tan (52)
blue green (very nearly a blue) (3)
light violet (84)
light tan (50)

Assortment VIII
medium red brown (C)
dark brown (48)
dark orange brown (66)
dark tannish brown (B)

Assortment IX
dark rose (blue evident) (23)
very deep rose (91)
very dark brown (P)
very deep rose (some tinge of red) (93)
very dark brown (68)

Assortment X
dark blue green (63)
medium violet (some tinge of red) (86)
saturated blue (76)
rose (blue evident) (25)
yellow tan (K)

Assortment XI
red (103)
very dark red brown (100)

Assortment XII
darkish yellow green (49)
saturated blue (24)
deep pink (73)
deep pink (touch of red) (87)

Assortment XIII
yellow green (65)
blue green (lighter than 'Jade Green') (57)
medium pink (85)

Assortment XIV
deep yellow (O)
darkish blue green (11)

In addition to sorting the skeins, the *S* was asked to select from a book of grey papers (containing 50 shades of Hering grey, published by C. H. Stoelting Co.) that sheet of grey which matched each of the 14 assortments of skeins which he had just made. This he did very quickly and easily. Assortment I he matched with grey no. 37; II, with a grey darker than the darkest (50) contained in the booklet; III he matched with grey no. 6; IV, with no. 3; V, with no. 41; VI, with no. 13; VII, with no. 7; VIII, with no. 44; IX, with no. 50 (stating that it was not a perfect match); X, with no. 27; XI, with a grey very much like no. 50; XII, with no. 26; XIII, with no. 19; and XIV, with no. 19. If we arrange these Arabic numerals, for the greys, in an ascending series, from the light greys to the darker greys, we get this sequence of the brightness-values of the assortments of skeins as arranged by this color-blind *S*: IV, III, VII, VI, XIII and XIV, XII, X, I, V, VIII, IX, XI, and II.

Scrutiny of the foregoing groupings of skeins, Table I, reveals that the *S* failed to separate reds from greens, yellows from blues, and other hues from their complements; nor did he succeed in segregating one pair from other pairs of complements. The order of his assortments, as well as his skill in matching the groups of skeins with suitable sheets of grey, indicates that his assortments were effected not by hue-discrimination but by brightness-vision. He is hereby revealed to be totally color-blind or an achromate.

In the color-blindness test X was permitted to place each skein as near his eyes as he chose and to take every advantage of the daylight in which he was working. From his behavior in handling the skeins it seemed evident that he was employing *foveal*, as opposed to *peripheral*, vision. The fact that he was not accessible for long-continued and more vigorous investigation prevented his being submitted to campimetry experiments or other techniques designed to differentiate more minutely between his foveal and his peripheral vision.

Also, inasmuch as his sortings were effected wholly by means of brightness-discrimination, the question may be fairly asked whether the distribution of brightness possessed by X is that of daylight or of twilight vision,—a question which naturally bears upon the question of foveal *vs.* peripheral vision. The color-blindness and brightness-matching tests were conducted in a room well-filled with early afternoon sunlight, and no opportunity was offered for submitting him to other tests during twilight or with techniques designed to measure the effects of darkness-adaptation. But in Table I, and in the paragraph which follows it, one finds that the first seven, or the brighter assortments of skeins,—IV, III, VII, VI, XIII, XIV, and XII,—contain exact-

ly 11 skeins exhibiting yellow, and only 6 skeins exhibiting any variety of green, blue-green, or blue; and the second seven, or the darker assortments of skeins,—X, I, V, VIII, IX, XI, and II,—contain almost no skein exhibiting a variety of yellow, and contain a great many skeins which exhibit green, blue-green, and blue. This fact would seem to demonstrate that X's brightness-vision is that of daylight, in which yellow stands out as the brightest hue in the spectrum, and shows a lack of Purkinje's phenomenon, or the relative increase of the brightness of greens, blue-greens, and blues under darkness-adaptation or in twilight vision. Purkinje's phenomenon is thought to be lacking in the fovea, where only cones are present, and to be a function of the rods of the peripheral retina. On the basis of the facts that X apparently used foveal vision and that his seriations of brightness failed to reveal Purkinje's phenomenon, and according to the current theory of the phenomenon, our *S*'s total color-blindness and also his brightness-discrimination were confined, in these experiments, to the cones of his retinas.

We shall next inquire whether or not X's brightness-vision, so useful in the sorting of the skeins, is normal; and if it is not we shall try to measure how defective it is and to ascertain the nature of the defect or defects. Our *S* was next submitted to the binocular, finger-fixation, homonymous-heteronymous images test. He was told to fixate with both eyes the farther of two fingers held opposite his nose at appropriate distances, and was asked to state what he saw. He reported, of course, that he saw the tip of the nearer finger double in the plane of the fixated finger, the far one. While he was still seeing the nearer finger as double, his left eye was shielded by an envelope held in front of it by the *E*, and immediately thereupon the fixated finger, the farther one, seemed to jump to his left. In similar manner, while he was experiencing heteronymous images of the near finger, the *E* shielded his right eye, and in this case the fixated finger seemed to jump toward his left. From the fact that in both of these cases the fixated object, the farther finger, moved to the left, and the additional fact that the right-hand image, that given by the left eye, was the clearer and the more definite of the two images, the conclusion was reached that his left eye was the stronger and that, in binocular use, it dominated over the right. When asked to fixate with both eyes a dot upon the blackboard, while one of his fingers was held nearer his eyes, outside the horopter, and when in this condition his right and left eyes were alternately shaded as in the preceding test, the dot always seemed to move toward his left. When the left was shaded, the dot jumped to the left and upward. The *S*'s right eye, upon examination, was found to be diverged outward,

i.e., temporally, and downward, and was far more diverged from the usual parallel position than was the left eye, besides being also the weaker of the two. One can easily imagine that it was difficult for him to obtain, without his glasses, a good binocular focus and to maintain it for a long period of time.

Having ascertained that X's right eye was weaker than his left, it was in order to attempt to discover really how weak his left eye was and how much stronger than the right it might be. The Snellen test-chart was used for this purpose. It was hung on a wall at a height permitting reading by a person standing erect. The lighting was that afforded by 6 windows on a bright afternoon in spring, and was such as to permit the *E* and four of the five students who engaged in the tests to read the letters on the chart correctly at the usual distances. The *S* stood at points designated on the floor by chalk; these markings represented m.-distances. At each specified distance, he was asked to read aloud those letters which should be easily legible to the normal eye at the given distance. Each eye was tested separately while the other was held shut with one of his hands. From several repeated tests, his vision was determined as being only 1/15 of normal in his right eye and only 1/10 of normal in his left eye. In other words, even if we consider both eyes instead of dealing with each singly, the *S*'s myopia was very great indeed.

Tested for astigmatism, with the Verhoeff chart, the *S* was shown to be astigmatic in both eyes, and the degree of astigmatism for the meridians in which it occurred was very pronounced. To the left eye, the radii numbered 1, 2, and 3 in the upper left quadrant of the chart and the corresponding radii in the lower right quadrant were clearly and definitely visible, while all other radii were almost completely invisible. It should be mentioned here that it was necessary, since he was without glasses in our tests, to have him stand very near the test chart, hung as in the myopia test, for, being 9/10 myopic, he could see nothing on the chart at the usual reading or seeing distance. The right eye enabled him to see clearly and definitely radii 2, 3, and 4 of the upper right quadrant and radii 1½, 2, 3, and 4 of the lower left quadrant, while all other radii were almost wholly invisible to him. His right eye, therefore, seemed to be astigmatic in quadrants the opposite of those which marked the astigmatism of the left eye.

A test of drawing, based upon perceptual discrimination, was next instituted. The *S* looked at a black horizontal straight line 5 cm. long and tried, by referring to it, to duplicate it in a drawing of his own. This was done 10 times, and five other persons were submitted to the same test in order to obtain check

data. The deviations of the drawings, in mm., from the true length of the standard or comparison line were noted; those exceeding the true length were checked as *plus* and those falling below the true length were noted as *minus*. The following Table II presents the 10 trials of the 6 persons.

TABLE II

S	A	B	C	D	E	X
	+ 4.0	+ 1.5	0.0	0.0	+ 2.0	+ 3.0
	+ 5.5	+ 2.0	+ 5.0	− 2.0	− 1.0	+ 10.0
	+ 9.0	+ 1.0	+ 2.0	− 1.0	− 1.0	+ 7.0
	+10.0	− 4.0	+ 2.0	− 2.0	− 3.0	+ 7.0
	+ 8.0	− 3.0	− 1.0	− 3.0	− 3.0	+ 9.0
	+10.0	− 3.0	+ 3.0	− 1.0	− 1.0	+ 14.0
	+ 2.0	− 4.0	+ 1.0	− 3.0	− 1.0	+ 11.0
	+11.0	− 3.0	0.0	− 2.0	− 1.0	+ 10.0
	+ 4.0	− 3.0	+ 2.0	− 1.0	+ 1.0	+ 13.0
	+ 7.0	− 2.0	+ 3.0	+ 1.0	+ 1.0	+ 16.0
Total	+70.5	−17.5	+17.0	−14.0	− 7.0	+100.0
Average	+ 7.05	− 1.75	+ 1.7	− 1.4	− 0.7	+ 10.0
			Ignoring signs			
Total	70.5	26.5	19.0	16.0	15.0	100.0
Average	7.05	2.65	1.9	1.6	1.5	10.0
A. D.	2.55	0.82	1.12	0.8	0.7	2.8

Average for first 5 persons: 2.94

The foregoing Table clearly demonstrates that our color-blind *S* was greatly inferior to 4 other persons in the visual discrimination and drawing of a line 5 cm. long, and was somewhat inferior to the fifth person, A. If his average is compared with that of his 5 competitors taken together, *i.e.*, 10.0 *vs.* 2.94 (even though the latter is weighted with the records of A), it is clearly evident that his inferiority was great. Also his deviation from his average is great, although calculated as a percentage of his average error it is less than that of any other person. This percentage is, for him, 28; for B, it is 31; for A, 36.2; for E, 47; for D, 50; and for C, 59. This fact can be interpreted to mean that his errors, in the 10 trials, were more consistent and constant than those of any other person; were least influenced by chance factors; and, presumably, were most, of those of all *S*s, influenced by defective vision. X's direction or kind of error was, however, not peculiar to himself or to his defective eyesight, inasmuch as A and C made *plus* errors, which fact indicates that they also underestimated the lengths of the lines they were drawing in making them conform to the seen standard. The other *S*s, B, D, and E, erred in the opposite direction, of overestimating the lengths of the lines they were drawing.

All 6 persons were asked 10 times each to draw from memory (that is, with no perceived standard before them except as they

themselves drew each time a line which in the act of drawing may have been a sort of perceptual guide) a straight horizontal line 3 in. or 76 mm. long. The errors were recorded as *plus* or as *minus* errors, in mm., as in the preceding test. The following Table III will illustrate how successful or unsuccessful X was in this task as compared with the other *S*s.

TABLE III

S	A	B	C	D	E	X
	− 9.0	0.0	− 4.0	+ 9.0	− 1.0	− 21.0
	−12.0	− 0.5	− 3.0	+ 1.0	− 4.0	− 5.0
	− 5.0	+ 4.0	+ 2.0	+ 6.0	− 3.0	− 6.0
	− 2.0	+ 5.0	− 1.0	+ 4.0	− 4.0	− 16.0
	− 3.0	+11.0	+ 1.0	+14.0	− 2.0	− 9.0
	− 6.0	+ 4.5	+ 2.0	+ 4.0	− 1.0	+ 1.0
	−12.0	+ 6.0	+ 5.0	+ 5.0	− 2.0	− 7.0
	−13.0	+ 9.0	+ 5.0	+ 3.0	− 2.0	− 8.0
	−22.0	+ 6.0	+ 2.0	+ 3.0	− 3.0	— 13.0
	− 9.0	+ 8.0	+ 2.0	+ 4.0	+ 1.0	— 5.0
Total	−93.0	+53.0	+11.0	+53.0	−21.0	− 89.0
Average	− 9.3	+ 5.3	+ 1.1	+ 5.3	− 2.1	− 8.9
			Ignoring signs			
Total	93.0	54.0	27.0	53.0	23.0	91.0
Average	9.3	5.4	2.7	5.3	2.3	9.1
A. D.	4.36	2.6	1.24	2.62	0.96	4.54

Average for first 5 persons: 5.0

The foregoing Table reveals that X, although inferior to the group of persons competing with him (9.1 *vs.* 5.0), was not inferior to A, nor was he as inferior as he was shown to be in the perceptual-discrimination drawing test. Computing his average deviation as a percentage of his average error, we find that his reactions were just as inconstant and variable as were the reactions of D, and that they were not much more variable than were the reactions of the other 4 persons, regardless of how defective his eyesight was shown to be. It is conceivable that his memory somewhat offsets his visual perceptual deficiency during the act of drawing, reducing his error greatly and making his inferiority not so obvious (especially as his memory of a 3-in. line may be much more accurate than his perception of such a length of line). It is to be noted also that A, who had not been revealed as showing signs of defective vision, was but slightly superior to him in the perceptual drawing test, and in the memory test did as poorly as he. With one exception, all of X's errors in this test were of the *minus*, or overestimation, sort. In the preceding test, they had been *plus*, or underestimation, errors. This change we believe is in itself indicative somehow of the use of memory in this latter test. Two other persons, A and E, likewise made *minus* errors in the memory drawing

test. Of these two, A had made *plus* errors in the perceptual drawing test, while E consistently throughout the two tests made the *minus* or overestimation type of error. B and D, who had erred in a *minus* direction in the first test, erred with underestimations in the memory test. C's errors remain constant in being underestimations of the length of the drawn lines throughout both tests.

In a test of the range of visual perceptual attention, in which an ordinary focal-plane camera-shutter tachistoscope, set with a tension of 1 (G)$\times 1\frac{1}{2}$ (F), was used with 10 stimulus cards bearing geometrical and algebraic signs and symbols each composed of 3 line-strokes and each being .5 cm. square, X gave the results which follow in Table IV.

TABLE IV

No. of Characters on Card (Presented in Irregular Order)	*No. of Presentations before All Characters Were Reproduced Correctly*
1	3
2	2
3	2
4	2
5	9
6	5
7	5
8	7

Judged in two ways, by the average number of items got correctly by the 5 persons who acted as check *Ss*, and by the average number of presentations required by these check persons before the unfailing reproduction of all characters was attained, X possessed a visual range approximately one-half of normal. To have been as efficient as this, with an eyesight only 1/10 normal in one eye and 1/15 normal in the other eye, X must possess a most remarkable apperceptive background which can supplement and correct what his retina furnishes during an act of reading. The suspicion that his memory frequently supplements and corrects for him in his acts of perceiving, we have already expressed with reference to his memory-drawing experiences.

In the last test, a test of brightness-discrimination in each eye singly, the brightness-discrimination-box (G. M. Whipple, *Manual of Mental and Physical Tests*, 1914, Part 1, 197) was employed. It carried a 40-watt frosted tungsten lamp in circuit with a 110-volt current. And, although our data are inadequate for presentation in tabular form, X was revealed to be greatly defective in the sort of discrimination required, and his right eye was shown to be inferior to his left eye.

It would be interesting to discover whether or not X's archromasia has resulted from the myopia and astigmatism which are so pronounced in him. Infrequently in the literature one meets the assertion that certain types of color-blindness arise from or are aggravated by the refractive errors which are also present, and that improvement in color-vision results from a correction of the refractive errors. It is to be noted, however, that X was just as color-blind, judging by his own statement and by the testimony of his friends, with glasses as without; and when allowed to place the Holmgren skeins very close to his eyes, and in any position with reference to light that he chose, he remained color-blind nevertheless. Moreover, his brightness-vision was infinitely more acute and sensitive than his color or hue discrimination, which was nil. And, although we were unable to obtain data concerning the heredity of X, we strongly suspect that all four of his defects, namely myopia, astigmatism, temporal and inferior strabismus of right eyeball, and total color-blindness, are due to hereditary influences.

THE INTERPRETATION OF FACIAL EXPRESSION

By DALLAS E. BUZBY, University of Pennsylvania

Boring and Titchener[1] recently reported a demonstration model for facial expression, especially of the emotions, which renders readily available for class work some of the faces described and pictured by Piderit.[2] By an interchange of a number of mouths, eyes, brows and noses, it is possible to obtain a wide range of facial expressions. Boring and Titchener illustrate their article with 24 typical faces which express most of the principal emotions.

It seemed worth while to determine the amount of scatter one would obtain from judgments on several of the typical faces. The following total expressions were chosen: Anger (not illustrated, but described under 19 by Boring and Titchener); Dismayed (Boring and Titchener No. 11); Horrified (No. 19); Disdainful (No. 22); Disgusted (No. 24) and Bewildered (No. 17). Sheets of paper were prepared, containing six similar lists of descriptive terms, in which were included all of the total expressions given by Boring and Titchener which they described by a single word, *plus* Anger. This list of 18 items will be found in the first column of Table I. The list was read over to the subjects, and they were told that all six lists were identical. The *S*s were shown the first figure, and were instructed to indicate the name in the first list which best described the expression. Then the second figure was shown, and the *S*s were instructed to mark the word in the second list, and so on.

The experiment was performed at the University of Pennsylvania during the winter and spring of 1924 on 716 students in the graduate and undergraduate schools. The records of the men and women were separated. The records were further separated on the basis of first course or subsequent course in psychology.

Table I contains the total scatter irrespective of sex or psychological maturity. In the first column are given the descriptive words in the lists. In the subsequent columns are given the number of times each of these terms was judged when the total expression at the head of the column was shown. The numbers

[1]E. G. Boring and E. B. Titchener, A Model for the Demonstration of Facial Expression, this JOURNAL, 34, 1923, 471-485.

[2]Th. Piderit, *Mimik und Physiognomik*, 1867.

in boldface type indicate, in each column, the "correct" judgments.

TABLE I

	Anger	*Dismayed*	*Horrified*	*Disdainful*	*Disgusted*	*Bewildered*
Pleased	169	—	3	—	—	2
Displeased	2	22	5	18	13	1
Stubborn	2	10	1	54	—	—
Attentive	5	330	—	3	—	47
Quizzical	82	134	—	7	—	81
Inattentive	2	9	—	37	—	18
Dismayed	29	46	25	11	1	44
Reverential	1	29	—	21	—	28
Affable	46	12	—	—	—	6
Bewildered	111	57	6	4	—	261
Amazed	62	16	39	2	—	226
Horrified	41	1	439	—	—	—
Raging	22	—	84	—	—	—
Disapproving	6	24	8	94	36	2
Disdainful	50	11	11	265	51	—
Anger	14	—	12	5	2	—
Contemptuous	65	7	12	152	236	—
Disgusted	7	7	71	43	377	—

For the Anger and Dismayed faces the scatter is great, and the number of correct judgments is small. Anger was judged most frequently as pleased, and very frequently as bewildered, quizzical, contemptuous, amazed or disdainful. Indeed, 10 of the 18 possibilities obtained a higher frequency than the correct one. The Dismayed face was judged as attentive with a very high frequency (over 46%), and also quizzical and bewildered were judged more frequently than the correct dismayed.

For all of the other four faces the scatter was much less, and in every case the correct descriptive term was marked with the highest frequency. The percentages of correct judgment are: Horrified, 60; Disdainful, 37; Disgusted, 53; and Bewildered, 37.

TABLE II

	WOMEN		MEN	
	Early	*Late*	*Early*	*Late*
Judgments made	804	864	2202	378
Judgments "Correct"	293	277	708	111
Percentage "Correct"	36.4	32.1	32.2	29.4

In Table II is given the analysis of correct judgments on the basis of sex and of psychological sophistication. In the first two columns are given the results for women,—the first column, marked Early, including the results of those taking the first course in psychology; the second column, marked Late, including those who have already had at least one course in psychology and who, therefore, have a certain degree of psychological sophistication. The results for the men are similarly arranged in the last two columns of the Table.

The results show a slightly greater percentage of right judgments in the case of the women, both sophisticated and unsophisticated. For both men and women there is a slightly greater percentage of correct judgments for the psychologically unsophisticated. None of these differences is great, however, although the tendencies seem to be true without exception.

It seemed worth while to analyse the results on the basis of each of the individual facial features. Inasmuch as 15 of the 18 descriptive terms chosen used the same nose, this analysis was made only on the basis of the mouth, eye and brow. The results will be found in Table III. In every case the values

TABLE III

	Anger	*Dismayed*	*Horrified*	*Disdainful*	*Disgusted*	*Bewildered*
Mouth	36	189	439	413	613	308
Eye	106	47	560	497	664	570
Brow	106	61	560	567	700	576

represent the total number of judgments for the facial expressions in which the correct individual feature was contained. It is apparent that the values for Anger and Dismayed are quite insignificant. The values for all three features for Horrified, Disdainful, Disgusted and Bewildered are all highly significant. It will be noted, however, that the values for the upper part of the face, brow and eye, are much more significant than those for the mouth.

Conclusions. (1) The total facial expressions of Piderit for Anger and Dismayed do not give a high percentage of correct judgments.

(2) The total facial expressions for Horrified, Disdainful, Disgusted and Bewildered give a high percentage of correct judgments, especially when one combines other descriptive terms which closely resemble the expression represented.

(3) An analysis shows that the upper part of the face, eye and brow, is more important for correct judgment of facial expression than the mouth.

(4) Women give a slightly greater percentage of correct judgments than men, and both men and women show a slight decrease in the percentage of correct judgments of facial expression with increasing psychological sophistication.

MINOR STUDIES FROM THE PSYCHOLOGICAL LABORATORY OF CORNELL UNIVERSITY

Communicated by E. B. TITCHENER

LXXII. OBLIVISCENCE DURING SLEEP AND WAKING

By JOHN G. JENKINS and KARL M. DALLENBACH

Ebbinghaus found that forgetting is a function of time:[1] it is very rapid at first, but becomes progressively slower as time elapses. According to the results of his experiments,[2] 41.8% of a series of nonsense syllables, as measured by the Method of Savings, is forgotten after an interval of 20 min.; 55.8% is forgotten after 1 hr.; 64.2% after 8.8 hrs.; 66.3% after 1 day; 72.2% after 2 days; 74.6% after 6 days; and 78.9% is forgotten after 31 days.

The results for the 8.8 hr. and 1 day periods are the least satisfactory; for, as Ebbinghaus himself points out,[3] the difference between the values for these successive periods is not of the same order as the differences between the values of the other successive periods. Between the 8.8 and 24 hr. periods there is a difference of 2.1%, whereas between the 24 and 48 hr. periods the difference is 6.1%; that is, in the later interval of 24 hrs. about 3 times as much is forgotten as during the earlier interval of 15 hrs. "Such a relation," says Ebbinghaus, "is not credible, since, according to all the other figures, the decrease in the after-effect suffers, with increasing time, a marked retardation."[4]

Ebbinghaus did not think the figures credible even under the plausible assumption that sleep—which formed the greater part of the 15 hr. interval and proportionately a much smaller part of the following 24 hrs.—materially retarded forgetting. He sought an explanation among the accidental errors of his experiments and thus neglected the investigation of obliviscence during sleep, the problem that was set by his results. Other experimenters[5] who have traced the curve of forgetting have likewise, in spite of the fact that similar discrepancies were observed by them at the same points, disregarded this problem. We have consequently taken it as the object of the present Study. It is our purpose to compare the rate of forgetting during sleep and waking.

Procedure. Two *Os*, L. R. Hodell (H) and J. S. McGraw (Mc), served throughout the course of the experiments. Both were seniors in Cornell University; neither had had any previous experience in memory experiments. Both worked without knowledge of the nature or object of the problem.

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[1] H. Ebbinghaus, *Ueber das Gedächtnis: Untersuchungen zur experimentellen Psychologie*, 1885, 85-109. English translation by H. A. Ruger and C. E. Bussenius, 1912, 62-80.

[2] *Op. cit.*, Table, 103.

[3] *Op. cit.*, 104.

[4] *Ibid.*

[5] P. R. Radossawljewitsch, *Das Behalten und Vergessen bei Kindern und Erwachsenen*, 1907, 1-197. C. H. Bean, The Curve of Forgetting, *Arch. of Psych.*, No. 21, 1912, 1-45. *Cf.* in particular 3 and 42. E. O. Finkenbinder, The Curve of Forgetting, this JOURNAL, 24, 1913, 8-32.

The *O*s were required to learn nonsense syllables which were typewritten on slips of paper and presented, by means of the Spindler & Hoyer memory apparatus, in series of ten. Exposure was made at the rate of 0.7 sec. The syllables were read aloud by the *O*s as presented. The vowels in half of the syllables were pronounced long, and in half short. Pronunciation was differentiated by placing dashes above the long vowels. These marks were distributed irregularly, but were so arranged that the long and short vowels occurred equally often in the various positions within the series. In every other respect Gamble's modification[6] of Müller and Schumann's rules was followed in the preparation of the series.

An adaptation of the Method of Retained Members was employed. The series were repeated by the *O*s until learning had come to the first correct recitation and then, after 1, 2, 4, or 8 hrs., a free reproduction was called for. The amount lost was taken as a relative measure of the amount forgotten.

An absolute measure of the amount forgotten is not to be obtained by this method; for, as repeated experiments have shown,[7] a single recall does not exhaust the amount retained, and the omissions from a free recall cannot consequently be taken as a direct measure of the amount forgotten. Though Finkenbinder found that "the measurement of forgetting made by means of free unaided recall does in some cases correspond somewhat closely with the measurement according to the *Ersparnismethode*,"[8] we should nevertheless have not ventured to use the method of recall if an absolute measure had been thought necessary. Such a measure, however, was neither necessary nor desirable; we were interested, not in tracing the absolute curves of forgetting in sleep and waking, but in comparing the two rates of forgetting; and a comparison could be made as well from a relative as from an absolute measure.

Had we sought an absolute measure, we should have had to use a more complex method, such as the Method of Savings; and we should have had to complicate the procedure by taking the diurnal variations of learning into account. The times of learning and of re-learning, the times of sleep and of waking, must have been varied and interchanged, and the number of experiments would consequently have been greatly increased. Not only did the routine duties of our *O*s forbid this procedure; the additional complications were not warranted by the results to be obtained. The absolute rate of forgetting has been sufficiently well established for waking; the only contribution that we hoped to make to the subject was the comparison of the rate of forgetting during sleep and waking.

The *O*s and the junior author, who acted throughout as *E*, lived in the laboratory during the course of the experiments, and regulated their lives, as far as possible, in accordance with the requirements of this Study. The times of learning at night varied between 11:30 p. m. and 1 a. m.; and the times of learning at day, with single exceptions for each *O* for every time interval, varied between 8 and 10 a. m. The exceptions mentioned were made for purposes of comparison and check, and the times of learning for them varied between 2 and 4 p. m. We were unable to regulate the times of learning more closely, since the time of learning had to be arranged with *O*'s schedule and the length of the time-interval in mind.

The following general instructions were given to the *O*s: "I am going to show you, with the aid of this apparatus, a series of nonsense syllables which I wish you to learn as rapidly as possible. The syllables will appear

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[6] E. A. McC. Gamble, A Study in Memorising Various Materials by the Reconstruction Method, *Psych. Rev. Mon.*, No. 32, 1909, 18 ff.

[7] W. Brown, To What Extent is Memory Measured by a Single Recall? *Jour. of Exp. Psych.*, 6, 1923, 377-382.

[8] *Op. cit.*, 32.

successively and will be visible through the little window in front of you. Give every syllable full and equal attention and pronounce every one aloud as it appears. All the vowels are to be pronounced short unless a long vowel is indicated by a dash over the letter. The syllables are without meaning. Do not attempt to read meaning into them. Do not use a mnemonic system in memorizing. When you can repeat the series in its correct order report the fact to me. Do not on any account repeat the series after you have left the experimental room."

The experimental room was adjacent to the improvised dormitory, and the experiments at night were not begun until *O* was undressed and ready for bed. *O* retired immediately after learning the series; and, as the rule of the sleeping quarters was quiet, distractions and retroactive inhibitions after learning were reduced to a minimum. *O*, after learning at day, went about his routine affairs.

Recall was always made in the experimental room with *O* seated before the apparatus in the position held during learning. During the experiments at night the *O*s were separately waked, after the appropriate interval, by *E*, who was himself waked by an alarm clock, and they were taken one at a time to the experimental room where their reproductions were received. After a few experiments *E* found it difficult to arouse the *O*s and difficult to know when they were awake. The *O*s would leave their beds, go into the next room, give their reproductions, and the next morning say that they remembered nothing of it. Unfortunately, it did not occur to *E* to apply special tests; he judged by the behavior of the *O*s, and assumed that they were awake.

The length of the interval between learning and reproduction was not known to the *O* at night; but during the experiments at day the following sentence was added to the instructions: "You will please report in this room for the reproduction at *x* o'clock,"—the hour depending upon the time of learning and the interval desired. We did not attempt to eliminate this difference between the experiments during waking and sleep. We might have done so by requiring the *O*s to report at the laboratory at every one of the intervals used in the experiment until the particular one desired was reached, or by informing the *O*s at night that they would be waked for their reproduction at such and such a time; but we thought both methods more objectionable than the existence of the difference. The first was objectionable because it would keep the experiment constantly in the *O*'s mind; because it would only partially accomplish the desired end—if the reproduction was not received at the 1, 2, or 4 hr. interval *O* would definitely know that it would be received at the 8 hr. interval; and because the effect of the blank appointments would probably be more disturbing than specific knowledge of the actual time of the reproduction. The second was objectionable because the attitude of the *O*s toward going to sleep differed according as they knew whether the reproduction would be given after a long or a short interval. The only way of equalizing the experiments during sleep was to keep this knowledge from the *O*s. Since *E* and the *O*s were not together throughout the day, the time of the reproduction could not similarly be kept from the *O*s during the day-time experiments.

After a short practice series the experiments began on April 14, 1923 and continued until June 7. With but few exceptions, on days when the *O*s were indisposed, experiments were conducted every night and every day. Particular care was taken to see that the *O*s' physical condition was constant, and the experiments were postponed whenever it was apparent that a fluctuation had occurred.

The time-intervals between learning and reproduction were varied at haphazard. We planned to have 8 experiments for every interval during both sleep and waking. The series were completed for the experiments during sleep; but H failed to complete two of the waking series, and Mc failed to complete one.

Results. The gross results of the Study are shown in Table I, which gives separately for every experiment with each *O*, and for every time-interval during sleep and waking, the number of repetitions required for the first correct recitation and the number of syllables given correctly in the subsequent reproduction.

TABLE I

Number of Repetitions for the First Correct Recitation and Number of Syllables Correctly Reproduced

	INTERVAL															
	1 hr.				2 hr.				4 hr.				8 hr.			
	Sleep		*Waking*		*Sleep*		*Waking*		*Sleep*		*Waking*		*Sleep*		*Waking*	
O	Rep.	Syll.	Rep.	Syll.	Rep.	Syll.	Rep.	Syll.	Rep.	Syll.	Rep.	Syll.	Rep.	Syll.	Rep.	Syll.
H	23	9	23	5	25	6	16	5	15	5	21	4	31	2	20	1
	18	9	23	6	15	3	14	2	20	5	17	3	29	3	17	0
	22	7	22	4	13	5	17	3	16	5	15	2	32	7	28	1
	14	4	21	4	18	9	26	3	16	5	15	1	20	9	22	0
	21	5	17	2	14	5	20	2	24	5	15	2	16	3	24	0
	19	6	19	4	10	6	12	2	23	5	18	2	12	7	17	0
	18	10	22	6	22	4			23	5	11	3	22	5	16	0
	20	7	14	4	14	5			15	7			16	8	15	1
Mc	36	8	33	7	28	6	17	2	20	8	26	2	22	5	18	1
	29	7	31	3	23	5	20	2	19	5	25	2	28	7	16	0
	24	6	20	3	23	5	16	2	19	5	25	2	19	4	20	2
	22	8	26	5	22	5	13	5	22	5	23	2	24	6	19	1
	18	7	17	5	21	5	17	5	22	7	16	2	20	7	20	3
	16	8	18	6	23	5	16	5	25	4	21	1	20	5	19	1
	17	5			20	7	20	2	22	7	13	2	25	4	22	3
	18	7			19	5	19	4	22	5	15	4	20	8	14	0

In computing the results only those syllables that were correctly reproduced were counted; partial credit was not given. The associative fusions,[9] such as the reproduction of *shog* and *riv* as *shiv*, of *ched* and *jeb* as *cheb*, of *baf* and *jop* as *bap*, of *juk* and *fuv* as *juv*, of *jev* and *jif* as *jef*, etc.; and the partial successes, such as the report of *tich* for *lich*, of *kay* for *kaq*, of *koj* for *foj*, of *tum* for *fum*, of *zuk* for *ruk*, etc.; were counted as incorrect.

Out of a total of 571 syllables recalled by the *O*s only 38, or approximately 7%, were partial reproductions. Each *O* gave 19, which were distributed among the time intervals and between sleep and waking as shown in Table II.

TABLE II

Distribution of Partial Reproductions

	INTERVAL				
O	After	1 hr.	2 hr.	4 hr.	8 hr.	TOTAL
H	Sleep	1	3	3	1	8
	Waking	1	3	5	2	11
	Total	2	6	8	3	19
Mc	Sleep	1	2	4	1	8
	Waking	2	1	4	4	11
	Total	3	3	8	5	19

[9] G. E. Müller and A. Pilzecker, Experimentelle Beiträge zur Lehre vom Gedächtnis, *Zeits. f. Psych. u. Physiol. d. Sinnes., Erg. Bd.* 1, 1900, 159-165; also G. E. Müller, Zur Analyse der Gedächtnistätigkeit und des Vorstellungsverlaufes, *Op. cit., Erg. Bd.* 8, 1913, 497-504.

The total number of partial reproductions is so small, and the difference in their distribution after intervals of sleep and of waking is so slight,—so slight, indeed, that it might be due to chance (2, 6, 8, and 3 cases and 3, 3, 8 and 5 cases occurred respectively for H and Mc at the 1, 2, 4, and 8 hr. intervals; and 8 and 11 cases occurred respectively for both *O*s after intervals of sleep and of waking),—that their omission, we felt, was justified, particularly as we were concerned in this Study only with the relative measure of forgetting.

A summary of the gross data shown in Table I appears in Table III, which gives, for each *O* and for every interval, the averages and the mean variations of the number of repetitions necessary for the first correct recitation and of the number of syllables correctly reproduced, as well as the total averages and mean variations for the sleep and the waking series.

These data show that there is a marked difference in the rate of forgeting during sleep and waking. On an average, as is shown in Table III under the caption "Totals," more than twice as many syllables are reproduced by both *O*s after intervals of sleep than after intervals of waking. On an average, 5.8 and 6.0 syllables were reported by H and Mc respectively in the sleep experiments, and only 2.4 and 2.8 syllables in the waking experiments. The superiority of the reproductions after intervals of sleep is also shown at every one of the experimental intervals. At the end of 1 hr. of sleep an average of 7.1 and 7.0 syllables was reproduced, whereas an average of only 4.4 and 4.8 syllables was reproduced after a like interval of waking. At the 2 hr. interval, both sleep and waking, there is a corresponding drop in the averages of each *O*; but the reproductions after sleep still maintain a decided superiority. This superiority becomes more and more pronounced as the length of the intervals increases; for the average number of reproductions for both *O*s continues to decline at the 4 and 8 hr. intervals of waking, whereas after like intervals of sleep the average of the 2 hr. interval is maintained. Indeed, in

TABLE III

Averages and Mean Variations of the Number of Repetitions Necessary for the First Correct Recitation, and of the Number of Syllables Correctly Reproduced

O		INTERVAL										TOTALS	
		1 hr.		2 hr.		4 hr.		8 hr.					
		Sleep	*Waking*	*Sleep*	*Waking*	*Sleep*	*Waking*	*Sleep*	*Waking*	*Sleep*	*Waking*	*Sleep*	*Waking*
H	Av.	19.4	20.1	16.4	17.5	19.0	16.0	22.2	19.9	19.5	18.5		
	m. v.	7.1	4.4	5.4	2.8	5.3	2.4	5.5	0.4	5.8	2.4		
	Rep.	2.1	2.6	3.9	3.6	3.5	2.3	6.3	3.6	3.9	3.5		
	Syll.	1.6	0.9	1.2	0.8	0.4	0.8	2.2	0.4	1.6	1.4		
Mc	Av.	22.5	24.1	22.4	21.7	21.4	20.5	22.2	18.5	22.1	19.8		
	m. v.	7.0	4.8	5.4	3.4	5.8	2.1	5.8	1.4	6.0	2.8		
	Rep.	5.3	5.8	1.9	1.8	1.5	4.4	2.5	1.9	2.8	3.6		
	Syll.	0.7	1.2	0.6	1.4	1.2	0.4	1.2	.9	1.1	1.4		

the case of Mc, the averages at the 4 and 8 hr. intervals increase slightly; and similarly, for H at the 8 hr. interval, the average is slightly greater than at the 2 hr. interval.

Comparative curves are shown in Fig. 1, in which the average number of syllables reproduced after the various time-intervals is plotted separately for each *O* and for the sleep and waking experiments. The curves of the waking experiments take the familiar form: a sharp decline which becomes progressively flatter. The form of the curves of the sleep experiments, however, is very different: after a small initial decline the curves flatten and a high and constant level is thenceforth maintained.

These results are not due to a difference in the depth of learning; for, as far as we were able to determine, this was constant for every experiment: learning was just brought to complete mastery; repetitions ceased at the first correct recitation. The statement that the depth of learning

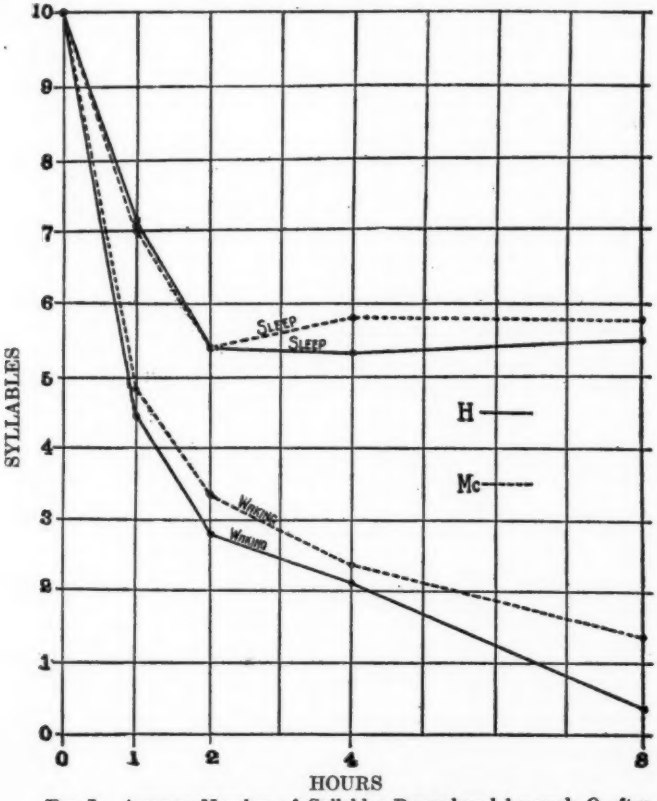

FIG. I. Average Number of Syllables Reproduced by each *O* after the Various Time-Intervals of Sleep and Waking

was constant holds, even if the number of repetitions be taken as the criterion, for the differences between the general averages of the number of repetitions at night and at day are too small to be significant. H averages 1 repetition more at night than at day, and Mc averages approximately 2 more. That these differences are not significant is shown by a comparison of the data for the various intervals. The general averages conceal facts which in this connection are important; the repetitions at the 1 and 2 hr. intervals for H, and at the 1 hr. interval for Mc, average less at night than at day. At the 1 hr. interval, the average for H is 19.4 at night and 20.1 at day, and for Mc, 22.5 at night and 24.1 at day; at the 2 hr. interval, the average for H is 16.4 at night and 17.5 at day. Nevertheless, in spite of the difference in the number of repetitions in favor of the experiments at day, a greater number of syllables were, as we have seen, reproduced after sleep than after waking. If the small differences were significant, opposite results should have been obtained. In view of these facts, we feel justified in re-affirming that our results are not due to a difference in depth of learning, but are due to a real difference in the rate of forgetting during sleep and waking.[10]

The difference in the rate of forgetting during sleep and waking is sufficiently large to account for the variation in Ebbinghaus' investigation. His figures for the 8.8 hr., 1 and 2 day intervals are not only "credible" but are confirmed by this Study.[11]

The constancy of the experimental conditions, or of *O*'s attitude, or of both, was greater after intervals of sleep than after intervals of waking; for, as is shown in Table III, the mean variation from the average number of syllables reproduced after sleep is relatively smaller for H, and both relatively and absolutely smaller for Mc, than the mean variation during waking. What effect the differences in the experimental situation had on our results, we are unable to say; but we feel certain that these differences are inherent in the problem and method.

A few subsidiary experiments were conducted with Dr. H. G. Bishop (B), instructor in psychology, and with W. F. County (C), an untrained *O*.

(1) The experiments with B were conducted to see how closely the results of an experienced *O* would agree with those of H and Mc. B's data, which appear in Table IV, are confirmatory of our general results; after 1 hr. of sleep B reproduced 9 syllables correctly, whereas he reproduced only

TABLE IV

1 hr.				8 hrs.			
Sleep		*Waking*		*Sleep*		*Waking*	
Repetitions	Syllables	Repetitions	Syllables	Repetitions	Syllables	Repetitions	Syllables
35	9	43	6	37	8	43	3

6 after 1 hr. waking; after 8 hrs. of sleep he reproduced 8 syllables, whereas he reproduced but 3 after a like interval of waking. The superiority of the reproductions after intervals of sleep is marked. It should also be noted, as confirmatory of what we have said regarding the number of repetitions required for learning, that B required fewer repetitions at night than at day.

(2) Since the regular *O*s might at night have given their reproductions, sometimes at any rate, in a hypnagogic state, experiments were made with

[10]The advantage of night-study thus becomes evident. Little is forgotten during sleep, and, on waking, the learner may take up the task refreshed and with renewed vigor.

[11]The discrepancies in Radossawljewitsch's investigation (*op. cit.*) may likewise be explained by our results.

C in the hypnotic state. The same procedure was followed in these experiments as in the waking series. When learning had come to the first successful recitation, C was brought out of the hypnotic state and told when to return to the laboratory. Intervals between learning and reproduction of 2, 4, 8 and 24 hrs. were used. When *O* returned he was again hypnotised, and was then asked to reproduce the series that he had last learned. At intervals of 2, 4 and 8 hrs. he reproduced the series correctly, and after the 24 hr. interval he reproduced 8 syllables of the 10. These experiments were performed during the daytime; and, except for the 24 hr. interval, the hours intervening between learning and recall were taken up with routine affairs. Approximately 8 hours of the 24 hr. interval were spent in sleep.

Though these results agree with those of Wienholt,[12] who found that "memory was intensified in the magnetic sleep," too few experiments were conducted with C to permit us to draw conclusions regarding forgetting during hypnosis, particularly as our results stand in disagreement with those of Beaunis,[13] who "found no essential difference in this respect between hypnosis and waking life," and with those of Dessoir,[14] who found "that memory is weakened in deep hypnosis." Our results, however, indicate, so far as they go, that a similar condition of retention and forgetting exists in the hypnotic and in normal sleep.

The results of our Study as a whole indicate that forgetting is not so much a matter of the decay of old impressions and associations as it is a matter of the interference, inhibition, or obliteration of the old by the new.

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[12]Quoted by A. Moll, *Hypnotism*, A. F. Hopkirk's translation, 1910, 122.

[13]*Ibid.* No references are given by Moll, so that we are not certain from what source this quotation is drawn. As the statement attributed to Beaunis appears in every edition of Moll's work, it is certain that Beaunis' study appeared before 1889,—the year of the first edition of Moll's *Hypnotism*,—and therefore before Ebbinghaus' standardization of the methods and technique of memory investigation.

Before 1889 Beaunis had published, according to Dessoir's *Bibliographie des modernen Hypotismus* (1888), the following articles dealing with hypnosis:

(1) Sur deux phénomènes produits pendant le somnambulisme provoqué. *Compt. rend. Soc. de biol.*, Ser. VII, 1, 1884, 362.
(2) Effet de la suggestion sur les actes organiques. *Op. cit.*, Ser. VIII, 1, 1884, 513.
(3) Études physiologiques sur le somnambulisme provoqué. *Rev. méd. de l'est*, 22, 1885, 674.
(4) L'expérimentation en psychologie par le somnambulisme provoqué. *Rev. philos.*, 20, 1885, 1, 113.
(5) Le somnambulisme provoqué. Études physiologiques et psychologiques, 1886.
(6) Un fait de suggestion mentale. *Bull. Soc. de psychol. physiol.*, 1, 1886, 39.
(7) Sur la spontanéité dans le somnambulisme. *Rev. philos.*, 23, 1887, 444.

Moll's quotation is probably drawn from the fourth article, where Beaunis says: "La mémoire (fixation des impressions) ne m'a pas paru être différente de ce qu'elle était á l'état de veille." Here, as the quotation shows, Beaunis is writing only of impression, a point upon which our results have no bearing. We have found that recall is intensified or augmented in hypnosis; and upon this point our results appear to corroborate Beaunis, who says (p. 16): "Dans la mémoire, il y a deux choses: il y a d'abord la facilité avec laquelle une impression quelconque se fixe dans le cerveau et il y a ensuite la facilité avec laquelle cette impression, une fois fixée, revient à la conscience ou autrement dit, ce que les Anglais appellent la *recollection*. Cette seconde aptitude est évidement augmentée dans le sommeil hypnotique. Pour la première, je ne saurais être aussi affirmatif."

[14]*Ibid.* Dessoir's results were communicated privately to Moll. As Moll merely summarizes them we are unable to draw a comparison between Dessoir's experiments and our own.

BOOK REVIEWS

RIVERS, W. H. R., *Conflict and Dream.* New York, 1923, pp. xi + 195. *Psychology and Politics.* New York, 1923, pp. vii + 181.

In these two posthumous volumes certain of the literary remains of the late W. H. R. Rivers have been collected and arranged for publication, with slight alterations and a few notes supplied by his friend G. Elliot Smith. The first volume deals in simple and often repetitious terms with Rivers' modification of the Freudian interpretation of dreams. Documented as it is with a number of dreams recorded both by the author and by certain of his former patients, a good case is made out for the thesis that dreams are not wish-fulfillments but are the expressions of some conflict in waking life. The peculiar character of the dream is not attributable, as Freud maintains, to a latent content derived from infancy and distorted by censorship; instead, the conflict is found to be a present one, although the content of the dream is that of an infantile, or at least of an earlier, level of development. Rivers denies the Freudian censor, and explains the grotesque and symbolic features of dreams by the process of regression to an infantile mode of experience. This transformation, which sleep imposes, is made to account for Freud's processes of condensation, displacement, plastic representation, and secondary elaboration; all these features of disguise, instead of being the effects of censorship, are held to be but a necessary consequence of the infantile mold in which the dream is cast. Although all dreams exhibit this feature of regression, there are also certain means of expression left open at the higher levels which find their way into the dream experience; because special systems of ideas remain active even after sleep has put other recent experiences out of action.

These recent experiences are more prevalent in dreams of light than of deep sleep. In the latter case the regression is more pronounced, and the content is more infantile. Although the conflict which supplies the motive is the same in both cases, the dreams of deep sleep are more distorted or transformed, and for this reason less likely to be remembered on awakening. The nightmare, which furnishes a possible exception to this rule, is remembered because of the greater affect which attaches to it.

The nature of the conflicts which determine dreams is by no means exclusively, or even generally, sexual; for although sex is an important motive, the instinctive nature of man furnishes many others.

A word should be added regarding the author's objection to the Freudian method of free association as applied to the interpretation of dreams; it is a "pure assumption," he writes, "that the experience to which free association leads has the importance universally attached to it by the psychoanalytic school."

The author's own method of analysing his dreams utilizes the state of drowsiness prior to full awakening for a review, more or less critical, of the dream-experience. Rivers found in his own case a special aid toward distinguishing the dream-content from that of waking life in the fact that images abounded in his dreams whereas he rarely experienced any when awake. A suggestion, which would fall in line with Rivers' general position, leads one to think that dream-imagery may be largely of the "eidetic" type recently distinguished by Jaensch and his school as being a chief characteristic of infantile experience. This suggestion might bear fruits if it were to be employed in the analysis of dreams.

The second volume under review consists of six addresses by Rivers, two notes by G. Elliot Smith, and a sympathetic appreciation of the author and his scientific work by C. S. Myers.

The first three addresses were prepared and delivered by Rivers as candidate of the Labor Party for representation of the University of Lon-

don in the House of Commons. They deal in a simple way with the application of instinct and conflict to social problems, and raise, among others, the significant question how far the immense communities of modern times can reach the harmony of social action attained by many small communities without a leader. The supplementary essays deal with *Socialism and Human Nature*, *Education and Mental Hygiene*, and the *Aims of Ethnology*. To the last of these G. Elliot Smith appends a note, in which he draws the consequences for psychoanalysis of Rivers' thesis that the similar beliefs and customs of different peoples are not attributable to uniformity of mind. According to Smith this new teaching destroys the foundations of belief in the reality of "typical symbols" which Freud and Jung have employed in support of their doctrine of instinct and the "collective unconscious."

Taken together, these two volumes, obviously intended for popular consumption, may be expected to do much good. Both Rivers' sanity and the clear and simple method of his exposition should go far to correct the extravagances of much of the popular psychoanalytic writing of our times. From his rich store of ethnological and psychobiological knowledge the author has been able to point the way to a more scientific attitude and interpretation.

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Cornell University

L'année psychologique, vingt-troisième année (1922). Ed. by H. Piéron. Paris, Félix Alcan, 1923. pp. xiii, 644. Price 40 fr.

With this volume the bibliographical part of the *Année* becomes definitely incorporated with French scientific bibliographies. The *Confédération des Sociétés Scientifiques*, which has taken charge of *L'Année biologique*, has also subsidized the *Année psychologique*. The committee on abstracts of the *Année biologique* has abolished its section on 'mental functions,' and the *Année psychologique* is now responsible for its publication. This arrangement is a fortunate one for psychology. For it not only insures financial support of the *Année*, but it also brings to the notice of psychology articles of interest from a dozen periodicals which heretofore have not regularly been represented in the psychological bibliographies. The *Analyses bibliographiques* of this volume contain some 750 abstracts and, in addition, the tables of contents of all important German psychological and psychopathological journals from 1914 to 1920. The bibliographical record broken by the war is thus finally repaired, and the *analyses* will now cover a single (from Oct. to Oct.) year.

The *mémoires originaux* consist of an experimental investigation and theoretical discussion of the Fechner-Benham colors (*Le mécanisme d'apparition des couleurs subjectives de Fechner-Benham*) by H. Piéron; an experimental study of the concomitant external inhibitions during the impression of meaningless words (*Les inhibitions externes concomitants au cours de la fixation des images*) by M. Foucault; an experimental study of the transfer of visual and kinaesthetic perceptions of extent (*Contribution expérimentale à l'étude des phénomènes de transfert sensoriel*) by Mme H. Piéron; researches on memory of forms (*Recherches sur la mémoire des formes*) by G. Dwelshauvers; and a psychotechnical study of certain tests of special abilities (*Étude psychotechnique de quelques tests d'aptitude*) by Mme H. Piéron.

Piéron has, in the interest of explanation, determined in great detail the conditions under which the Fechner colors appear, and has formulated a general theory in a pair of laws. The basis of his explanation is that the visual psychophysical processes are not excited at the same rate, and that when black and white discs are rotated at the proper rates the release of the various chromatic processes occurs at different times, thus producing the successive colors. Despite the fact that Piéron has carefully reviewed the earlier literature, he has unfortunately overlooked Bagley's study

(this JOURNAL, 13, 1903), which anticipated not only some of his facts but also the fundamental idea of his theory. Foucault means by the phrase 'concomitant external inhibition' what is ordinarily called 'distraction.' He reports experiments which show that, in the learning of nonsense syllables, the inhibiting effect of a beating metronome disappears after an interval which varies with the subject, and then becomes facilitative. He fails to mention either Geissler or Cassel and Dallenbach, who found similar results in other fields. Mme Piéron's first paper is a comparison of the average errors in judging visual and kinaesthetic (both active and passive) extents and in transferring the judgment from one modality (or, if kinaesthetic, from one hand) to the other. The results are purely quantitative, and too numerous and complex for a brief review. Their psychological significance is not discussed. Her second contribution is a report of the scores and intercorrelations of six tests: Claparède's permutations, Claparède's memory test, Binet's 'absurd phrases,' Whipple's formation of words, Woodworth and Wells' analogies, and Rybakoff's test of simple changes. Dwelshauvers' investigation, which may be regarded as a continuation of one reported by Piéron two years ago, is of the memory of drawings either of meaningless figures or of geometrical forms variously combined. The method was similar to Philippe's. The author attempts a quantitative analysis of his results, and tends to explain them in terms of the unconscious.

The *Notes et revues* comprise two articles by Piéron, the one a discussion of the difference between tests of special abilities and tests which attempt to measure mental development, the other a critical review of the experimental literature of auditory localization; and a third by I. Meyerson, on primitive mentality, àpropos of Levy-Bruhl's book.

The *Chronique* is, as usual, a useful summary of the psychological events of the year. H. P. W.

Goethe als Psycholog. By JOHANNES VON KRIES. Philosophie und Geschichte, Nr. 5. Verlag von J. C. B. Mohr (Paul Siebeck), Tübingen, 1924. pp. 52. Price GM. 1.

This paper is a reprint, with notes, of an address delivered before the *Goethe-Gesellschaft* im Weimar in 1919 and published in their *Jahrbuch* for 1920 under the title of *Goethe als Naturforscher*—the topic originally assigned to von Kries. This double title is not without significance; for, though the author has felt that the narrower one was more appropriate to the partial treatment which the limits of an address made necessary, the reader will find that the first third only of the paper has to do with Goethe as a psychologist and the remaining and more important two-thirds with Goethe as man of science and philosopher.

Every poet, except perhaps the pure lyricist, has of course to be a kind of an empirical and practical psychologist; and when he is interested, as Goethe was, in the precise description of persons and in the characteristics of the sexes, of groups, classes and nations, and of the life-stages of man, we are apt to find him forming empirical generalizations which are at least quasi-scientific. Of such generalizations Goethe's works have their full share, and not a few of them have a very modern sound—evidence of how little empirical and practical psychology has advanced in a century!

The last two-thirds of the address deal with Goethe's psychology only in the sense that they set forth how his own mind worked in his scientific observing and the epistemological conceptions under guidance of which he studied nature. For Goethe the way to arrive at truth is to use the senses carefully and skilfully—to observe, especially to *look at* things—and then let the mind take its own safe and natural course in the apprehension of them. In his own observations he was especially interested in the discovery of types and uniformly changing series of phenomena, which are apprehended in that immediate way. For speculation apart from experience he had no

use, and even of theory he was suspicious. Theories, he thought, were "commonly the hasty output of an impatient spirit, anxious to be rid of the phenomena." For mathematics also he had no great liking; and at no point, perhaps, is the contrast between his attitude and that of modern scientific workers more sharp than with reference to the ideals which have come in through the increased use of that instrument of mechanical precision; Goethe's attitude was a "naive-sensory" one, while that of the modern man of science is the "abstract-mathematical,"—all of which means, however, no disparagement of Goethe's exceptional scientific gifts nor any lessening of the value of his discoveries and prophetic conjectures, but simply that science has advanced since his time.

Goethe also was by nature little interested in epistemological criticism with its subjective orientation; his own mind faced the other way—toward what is objective, active, ethical. "How can one learn to know himself? Through reflection never; but rather through action. Try to do thy duty and thou knowest at once what concerns thee." With this is connected, on one side, his reliance upon direct observation. We are equipped with all that is necessary for learning all of nature that we need to know. Nature "hides no secret that she does not somewhere lay open naked before the eyes of the attentive observer;" and what she does not want to reveal no compulsion can force from her. There are therefore for Goethe limits to investigation which it is foolish to try to go beyond, matters "of which," he once said, "the deity knows no more than I." The same active-ethical attitude is, on the other side, the key to another fundamental aspect of Goethe's scientific thought: its essentially religious character. Before him shone, as a supreme and not unattainable hope, the belief that through science God and Nature might reveal themselves to the faithful seeker. For this end he observed precisely, reverently and with open mind. With this also, perhaps, was connected the double feeling for nature so characteristic of him: the aesthetic delight in all her rich and colorful yet ordered variety; and his deep reverence for her. "Everything else," he said, "is more or less plastic, lets us do more or less with it. Nature, however, stands no fooling; she is always true, always serious, always unyielding, always right; the errors and mistakes are Man's." What finer incentives for scientific work could there be than these two: delight and reverence!

E. C. S.

(1) *The Depths of the Universe.* By GEORGE ELLERY HALE. New York, Charles Scribner's Sons, 1924. pp. xv+98; forty-four illustrations. Price $1.50.

(2) *The A B C of Atoms.* By BERTRAND RUSSELL. New York, E. P. Dutton & Co., 1923. pp. 162. Price $2.00.

To the psychologist seeking the stimulus of an excursion to the frontiers of sciences remote from his own these two little books may be heartily commended.

(1) The first, by the Director of the great astrophysical observatory on Mt. Wilson, California, is a reprint of three articles which have appeared during the past two years in *Scribner's Magazine*. They tell engagingly and authoritatively of the methods by which astronomers have recently been plumbing the depths of space and of the results obtained, of Barnard's dark nebulæ, and of the magnetic peculiarities of the sun-spots.

(2) The second presents, with the ease and clarity of a master, a sketch of the recent advances in the border-land between physics and chemistry—electrons, the hydrogen atom, the theory of quanta, radioactivity and the like—so far as they can be made comprehensible to the layman, which under Russell's hand means to a very interesting degree, not omitting a suggestion of the philosophical questions which these things raise. The work is a model of what popularization at its best may be.

E. C. S.

NOTES

Dr. Spencer's Experiment on Retroactive Inhibition[1]

Dr. Spencer has discussed the results of his own very interesting experiment largely in terms of the critical light which he assumes they throw upon an experiment of mine.[2] Before commenting upon Dr. Spencer's investigation I should like to state that I am in thorough agreement with him upon at least one important point: further work must be done before we can accept as of general significance my finding that the degree of retroactive inhibition is independent of the temporal position of the retroactive interpolation.

In his own experiment, however, Dr. Spencer has failed to isolate the problem upon which I, taking my cue from Experiment 34 of Müller and Pilzecker,[3] made an attack. The plan of the Spencer experiment is justifiable in itself; but it most assuredly is not analogous to the Müller and Pilzecker experiment nor to mine. Dr. Spencer measured the retroactive effects of interpolated learning placed 9 sec. after the study of an original list by comparing recall under this condition with recall after a similar interval not spent in learning a second list. He measured the retroactive effect of interpolated learning placed 20 min. after the study of an original list by comparing recall under that condition with recall after an equal interval of time not spent in learning an interpolated list. He then compared the degrees of inhibition found under the two pairs of conditions, and from this comparison concludes that the more remotely interpolated learning has a less retroactive effect than the more immediate. It is quite as likely that his results are due to the fact that the retroaction of his experiment was measured at two different temporal positions after original learning as to the fact that two temporal positions were employed for the interpolated learning. In my experiment there was a total interpolated period of *constant* length within which the interpolated learning was placed in varying temporal positions.

Edward S. Robinson
The University of Chicago

Summation Tones: A Correction

In a previous study of difference tones obtained from tunable bars (this Journal, 33, 1922, 386) I wrote: "We might add that f^2 combined with $f\#^2$, and also $f\#^2$ combined with g^2, which are the lowest bars upon our instrument, yield unusually clear summation tones. The tone of the first combination can readily be heard as higher than that of the second."

The tones in question are not summation tones. If they were, the combination of f^2 and $f\#^2$ would give a *lower* tone than $f\#^2$ and g^2, since f^2 has a lower frequency than g^2. Repeated observation, however, has confirmed the original statement of fact that the tone from the first combination is *higher* than that from the second.

At the present time I cannot explain the observation, but I suggest two possibilities. (1) The so-called summation tones may be difference tones of a higher order than the first, which were misjudged by an octave. (2) The so-called summation tones may be difference tones generated by higher partials in the clang.

Paul Thomas Young
University of Illinois

Errata

In the article, "A Further Study of Revived Emotions," which appeared in this Journal for January, 1924, the following corrections should be made. On page 115, line 15 from top, '74%' should read '7.4%'. On the same page, between lines 18 and 19 from top, insert: "Of the cases where fear was recalled from position 3, 35% had the longest time of recall and 5% the shortest."

M. F. Washburn
Vassar College

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[1] This Journal, 35, 1924, 466.
[2] *Psychol. Monog.*, 28, 1920, 36-40 and 53.
[3] *Zeits. f. Psychol. Ergbd.*, 1, 1900.

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